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Asset and Liability Management in the Developing Countries

Modern Financial Techniques

A Primer

Toshiya Masuoka

The increased volatility of exchange rates, interest rates, and primary commodity prices over the last two decades has highlighted the importance for developing countries of managing these risks.

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This paper -- a product of the Office of the Vice President, Development Economics -- is part of a larger effort in PRE to explore the possibility of developing countries using financial market transactions to hedge their exposure to external shocks. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Sook Bertelsmeier, room S9-039, extension 33767 (56 pages with boxes, figures, and tables plus 6 pages of appendix).

The increased volatility of exchange rates, interest rates, and primary commodity prices over the last two decades has highlighted the importance for developing countries of managing these risks. Asset and liability management — a risk-management technique to systematically control price risks with market-based financial instruments — has been developed and broadly used in the industrial countries. But its applications to developing countries have been limited.

Asset and liability management is designed to quantify risk exposure explicitly in the planning process, and to carry out hedging activities with financial market transactions. It could provide an opportunity to reduce the effects of external shocks and complement a country's long-term development planning.

Drawing on the recent studies on theory and practice, Masuoka provides a primer for persons interested in a country's risk-management. Emphasizing practical aspects, the primer presents five major issues:

- The concept of asset and liability management at the country level and the methods of risk exposure measurement.

- Basic characteristics and mechanisms of modern financial instruments — including forward, futures, option, and swap contracts and examples of simple risk-hedging activities with these instruments. Commodity risk management instruments, such as commodity swaps, commodity-linked loans, and commodity bonds are also explained.

- Actual applications of modern financial techniques by some developing countries.

- Factors impeding developing countries' use of modern financial tools and some ways to remove these factors.

- The World Bank's technical assistance programs for helping developing countries improve their risk management.

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I. Introduction

1. Throughout most of the 1970s and 1980s, the world has experienced volatile interest and exchange rates, and primary commodity prices. Both nominal and real interest rates have fluctuated dramatically. Nominal six-month U.S. dollar LIBOR interest rates have moved between 5 percent and close to 20 percent, while real interest rates (LIBOR adjusted by a developing countries export price index) have been more volatile.[1]/ Major exchange rates--both nominal and real--have also fluctuated widely since the move to the floating rate system in 1973. Commodity price movements have been even more volatile, with large shifts in the supply of and demand for individual commodities.

2. These external shocks have made it difficult for developing countries to service their debts and pursue economic development. Developing countries are very exposed to the risks of international price volatility and vulnerable to the adverse movements of the prices. Commodity exports account for more than 40 percent of developing country exports. A large part of their external debt carries variable interest rates denominated in one of the major currencies, mostly in dollars. While many efforts, such as international commodity agreements and export diversification, have been made to deal with such fluctuations, the variability of international prices is mostly seen to be beyond the control of developing country policymakers.

3. The financial markets have responded to high price volatility with a number of new, market-based financial instruments including futures, forward, option, and swap contracts. These instruments have been used to meet

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[1]/ IMF, Occasional paper 65, June 1989.

the continuous needs of risk management by financial institutions and corporations, first to handle currency and interest rate risk. In commodity price risk management, innovations are currently under way. Recently, an increasing number of corporations in the industrial countries have started using commodity swaps, commodity-linked bonds, and the like.

4. The concept of asset and liability management has been developed against this background. For financial institutions and corporations, asset and liability management includes those activities that attempt to control exposure to financial and other price risks. It aims at controlling the variability of future cash flows. Institutions and corporations examine the risk exposure of their assets and liabilities to future asset and commodity price movements to obtain a summary of their risk exposure profile. By entering into a set of financial transactions, they attempt to minimize any unexpected decline in profits (net cash flows from operations) resulting from changes in interest rates, exchange rates, and commodity prices. While the importance of these activities has been broadly recognized in the industrial countries, applications to the developing countries have been limited.

5. The purpose of this paper is to provide a primer of:

- a concept of asset and liability management applicable to a country; and
- modern financial instruments and hedging activities with these instruments.

While many theoretical or technical papers on these issues can be found, there seem few that provide a summary picture covering both aspects. The paper attempts to provide such a summary that can be an introductory guide to practical applications of a country's risk management activities. Because

understanding modern financial techniques is very important for carrying out asset and liability management, the paper provides basics of these instruments and examples of their actual use by developing countries. Asset and liability management provides an opportunity to reduce the probability and effects of external shocks, and enables governments to make development planning steadier and more concrete. It may complement medium-term structural adjustment programs because risk-management operations reduce the possibility of unanticipated deviations from initial projections in important economic variables.

6. The following chapter describes the concept of asset and liability management in the developing countries. Chapter III gives an explanation of financial instruments. To illustrate practical applications of these instruments, several examples of developing country risk-management activities are presented in Chapter IV. The chapter also discusses some factors that limit the developing countries' use of modern financial tools and considers ways to remove these factors. The paper concludes with a description of the World Bank's assistance programs in this area.

II. Asset and Liability Management in Developing Countries

A. General Concept

7. In the industrial countries the techniques of asset and liability management were initially used by financial institutions to control unexpected downturns in net interest income[2]/ due to changes in market interest rates. The notion has later expanded to include the risks of changes in currency exchange rates and commodity prices as well, and to be applicable to other types of organizations.[3]/

8. The main purpose of asset and liability management is to make the consideration of risk explicit in the planning process and to enable decisionmakers to control risk exposure. Any entity or investment project is bound to be exposed to price risks, and investment planning always involves assumptions about the movements of these prices. Many of the difficulties that the developing countries have suffered in servicing their debts in the 1980s reflect such implicit assumptions on future prices of terest rates, exchange rates, and commodities. Asset and liability management analysis is designed to quantify the sensitivity of an investment's performance to these

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[2]/ Net interest income is the difference between the total revenue on interest-bearing assets and the total expense on interest-bearing liabilities. Net interest margin is often used as an objective function in asset and liability management, too. It is derived by dividing net interest income by interest-bearing assets or total assets.

[3]/ In the financial institution's asset and liability management, the institution pays primary attention to the "match" and "mismatch" of the maturity structures of its assets and liabilities. If mismatches of maturities (interest rate repricing periods) between assets and liabilities exist, the institution is exposed to interest rate risks. Toevs and Haney (1986) present a good description of techniques the financial institutions use to control these risks, such as the "maturity gap" method and the "duration gap" method.

price changes as accurately as possible, and to carry out appropriate hedging activities to alter the level of sensitivity.

9. Asset and liability management involves the following procedures:

1) Identifying an objective function (or a measure of an entity's performance);

2) Identifying and measuring risk exposure in relation to the objective function (or measuring the sensitivity of performance to unexpected changes in prices);

3) Deciding on an acceptable degree of risk exposure (or deciding on the degree of risk exposure to be hedged);

4) Choosing and executing hedging transactions.

10. An objective function is a quantitative measure of an entity's performance, which is used for risk measurement. For a company, for example, an objective function may be defined as net profit from operations. Net profit fluctuates over time due to various factors including a company's investment strategy, competitiveness in the market, and financial prices such as foreign exchange and interest rates, and commodity prices. The company then divides the fluctuations into two categories: those related to movements in financial prices and those unrelated. The fluctuations correlated with financial prices are called financial risk facing the company. Hedging against the risk with financial instruments, the company can reduce fluctuations in its net profit resulting from price movements in financial markets.

11. For a country, an objective function can be defined in a quite general way as well as in a more reduced, simple form. This paper follows a simple approach, but draws on several studies that propose a general objective

function. Such researches propose that a country's objective function be defined in terms of a general social objective function (for instance, a utility function over country's consumption), assuming that the country seeks to maximize it.[4]/ Although a general model provides a good theoretical base for identifying a country's objective function and risk exposure, further specifications are needed for practical applications. In fact, the above studies on general approaches reduce such a general objective function to a more specific target (for instance, country's net foreign receipts, and so on). This paper follows such a practical approach.

B. Practical Asset and Liability Management

12. This paper defines asset and liability management as the management of the country's asset and liability structure to minimize adverse changes in future net cash flows from international transactions due to external shocks.[5]/ This definition implies that the country is risk-averse, and that it tries to avoid disruptions in its international transactions arising from unexpected changes in world prices.[6]/ (An overview of asset and

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[4]/ Claessens (1988) presents such a conceptual framework in terms of exchange rate risk using an intertemporal expected utility function defined over the country's consumption of different goods. Myers and Thompson (1989) address commodity price risk with a consumption utility function defined over real imports of goods and services per capita. This can be interpreted as the reduced form of a more complete utility function that includes consumption of tradable and nontradable goods.

[5]/ External shocks may affect not only prices but also quantities. Asset and liability management can not eliminate quantity risks such as an export shortfall, but attempts to reduce the effects from unexpected price changes.

[6]/ It is implicitly assumed here that the country does not take an active view on the price movements of a particular asset or commodity, and that the country focuses on minimizing risk under given expected value of future cash flows.

liability management is provided in Table 1.)

13. The definition specifies a country's "objective function" as relating to future net cash flows from international transactions. Net cash flows mean the cash in-flows generated from a country's assets, net of cash out-flows required by liabilities. The cash flows should be viewed in terms of the country's economy as a whole, but can be examined for subsectors, such as the government budget and the central bank's accounts. Practically, cash flows to and from the country can be derived by reclassifying items in the balance of payments data. For a further use of risk analyses, the items should be reclassified in terms of the composition of currencies and commodities. Alternatively, cash flows can be classified in two parts: external debt service requirements (cash required to service external debt on schedule), and the country's ability to service the debt (export earnings, and so on, net of import costs).

14. This approach focuses on cash flows rather than on asset stocks. Here, any factor that generates future in-flows of cash is loosely defined as an asset, and any factor resulting in out-flows of cash is viewed as a liability. Thus earnings on export activities are viewed as dividends on assets, or revenues from the sale of assets. By the same token, import activities are classified as liabilities (see Table 2).

15. The asset and liability structure can be changed directly, by changing the amounts of given assets or liabilities in the balance sheet, but also indirectly, with available hedging instruments that change the characteristics of the returns on the assets and liabilities. For instance, a country can improve the risk characteristics of its assets and liabilities either by holding an adequate level of foreign exchange reserves and borrowing

TABLE 1

Overview of A Country's Asset and Liability Management

Asset and Liability Management

Management of the country's asset and liability structure to minimize adverse changes in future net cash flows from international transactions due to volatility in financial prices.

Objective Function

Measure of the country's performance -- future net cash flows from international transactions.

Net Cash Flows

Cash in-flows generated from a country's assets, net of cash out-flows required by liabilities.

Assets and Liabilities

Assets -- items generating cash in-flows,
Liabilities -- items generating cash out-flows.
See Table 2 for sample classifications.

Risk

Fluctuations in future net cash flows due to fluctuations in exchange rates, interest rates, and commodity prices.

Risk Exposure

The extent to which fluctuations in future net cash flows are attributable to fluctuations in exchange rates, interest rates, and commodity prices.

Risk Exposure Measurement

Regression Analysis
Measures the amount of changes in net cash flows for every one unit change in financial prices, based on historical data.

Simulation Analysis
Measures the amount of changes in net cash flows for every one unit change in financial prices, based on projected data under assumptions on relevant future events.

Hedging

Activities (with financial instruments) to insulate future net cash flows from fluctuating with financial price movements.

TABLE 2

Sample of Assets and Liabilities
(For a Country)

Asset Items

Exports of Goods

Revenues on Tourism

Workers' Remittances from Abroad

Earnings on Foreign Exchange Reserves

Liability Items

Imports of Goods

Expenses on Transportation and Insurance

Remittance of Dividends on Direct Investments

Interest Service of External Debt

Repayment of External Debt

Separate Items1/

Highly Concessional Transfers from Abroad

Commodity Stabilization Funds

Compensatory Financing Facilities2/

1/ Items which should be separately treated from other assets and liabilities. These items already include some risk management features, and thus, might cloud measurement of true risk exposures in the historical data analysis.

2/ See Chapter III, Footnote 11.

in appropriate currency denominations, or by executing hedging transactions in futures and swap markets.

C. Risk Measurement

16. Two basic methods can be used to measure a country's risk exposure: measurement based on historical data, and measurement based on projections or simulations.

17. The first approach aims at extracting meaningful relationships between net cash flows and risk factors through analyzing historical data, usually through multi-variate regression analyses. The risk exposure with respect to each risk factor is measured by the covariance between the cash flows and the risk factor, relative to variance of the cash flows (that is, regression coefficient).[7]/ Put another way, the risk exposure is measured as the amount of changes in the cash flows for every one unit change in financial prices (Box I gives an example of risk measurement). Although this approach provides a relatively convenient way of measuring risk, the approach tends not to take into account future changes in the country's economic structure. While using this approach which is based on an extrapolation of historical trends, one should attempt to predict and factor in future changes in the country's economic structure, which may drastically alter the country's risk exposure profile.

18. The second approach, the simulation method, extends the first approach by systematically incorporating future structural changes. It does this through projecting future cash flows based on several sets of assumptions

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[7]/ See Adler and Dumas (1980), Oxelheim and Wihlborg (1987), and Park and Pick (1989).

on future price movements and the country's economic structure. It draws on statistical estimates of the variability of net cash flows with respect to changes in the prices of risk factors. While this approach is preferable, the quality of the analysis is largely dependent on the validity of assumptions on future events. Usually both approaches are carried out and the results are compared with each other to check plausibility and to illustrate the effect of the future structural changes on the risk exposure.

Box I

Risk Exposure Measurement -- Methods and Applications

1. The following example illustrates the methods of risk measurement and their applications to a country. Studies carried out by the World Bank on several countries have been consolidated and simplified to produce this example. A small hypothetical country, Country P, is used in the example.

A. Country P's Profile

2. Country P is a very small country whose primary exports are minerals (67 percent of the total exports) such as gold and copper, and agricultural commodities (20 percent) such as coffee and cocoa. The major imports are machinery (30 percent of the total imports) and wheat and rice (17 percent). The major export partners are Japan, West Germany, and the U.S. The import partner is mainly Australia. The trade invoices are primarily denominated in the partner's currency. The current account is slightly negative, but does not reach an alarming level under the current high price of gold and copper. Country P has a modest level of external debt primarily denominated in Australian dollars (A$), U.S. dollars (U.S.$), and Japanese yen (Yen). Interest rates on 10 percent of the external debt are linked to short-term floating rates, but the interest payments alone do not seem to cause any heavy burden on Country P, considering the current level of modest external financing. Country P is carrying out a petroleum project. If the project is on schedule, the country will become an oil exporter in three years.

B. Risk Measurement by Regression on Historical Data

3. The historical data analysis on the balance of payments and debt repayment schedules indicates that the country is primarily exposed to exchange rate risk in terms of A$, deutsche marks (DM), Yen, and U.S.$. Country P is also exposed to commodity price risk in terms of copper, gold, cocoa, and coffee. Interest rate risk is negligible.

4. To measure the exposure to exchange rate and commodity price risk, several versions of regression analyses can be carried out. For example, a simplified regression equation to estimate the sensitivity

of country's net exports to exchange rates can be described as follows;[1]/

$$\log (CF) = a + \Sigma b_i \log (E_i) + e, \quad \Sigma b_i = 1$$

where CF is the net exports in terms of the domestic currency; E_i is the exchange rate of currency i, in terms of the domestic currency (the domestic currency value per unit of a foreign currency). The log term is used to capture the elasticity of net exports with regard to the exchange rate. The coefficient b_i represents the sensitivity or risk exposure of net exports to exchange rate E_i. Estimating b_i's for each currency (and re-scaling b_i's in such a way that the sum of all b_i's is equal to one), a desirable share of each currency for minimizing risk is derived. Then, these shares are compared with the current (currency) composition of the external debt. In the case of commodity prices, the shares indicate the extent to be hedged with long-term forward contracts or commodity-linked instruments.

5. The regression analysis indicates that the desirable currency composition of debt is the following;

A$	DM	Yen	U.S.$	Others
-44%	79%	35%	24%	6%

(A negative sign indicates net lending in the currency.)

The current composition of the external debt is;

A$	DM	Yen	U.S.$	Others
20%	5%	32%	30%	13%

Country P is greatly exposed to A$ and DM risk, but has a reasonably balanced share in terms of Yen and U.S.$. The analysis indicates that Country P should have the liability structure more linked to DM and less linked to A$ (in which the country's major import is denominated). In terms of commodities, a regression indicates that the country is significantly exposed to copper and gold price risk as well as coffee and coca price risk:

Copper	Gold	Coffee	Cocoa	Others
32%	10%	24%	18%	16%

The figures indicate that these shares of external debt repayments should be, in some way, linked to these commodities (for instance, copper-linked loans and gold swaps).

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[1]/ The equation is simplified for the illustration purpose.

C. Risk Measurement by Simulation

6. The regression analysis estimates "ex-post" desirable shares of currencies and commodities. If the country's economic structure is reasonably expected to be unchanged in the near future (3-5 years), the regression results may be a good estimate of the risk exposures. However, Country P will face a major change in the next few years: it will become an oil exporting country. In this case, simulation analysis may help in estimating the sensitivity of future cash flows to the risk factors. The simulation can be carried out by setting up several scenarios on the exchange rates and commodity prices (see the table below). Also, several scenarios should be set up for different timing of the oil project's completion and different capacity of the oil exports.

Sample Results of Simulation Analysis.

Net Exports Sensitivity	Deviation from Base Case
Gold Price	4.1%
Copper Price	9.5%
Oil	6.4%
Coffee	5.5%
Cocoa	3.8%

Note: Average percentage of deviation from a base case scenario (for the next five years) in the current dollar value of net exports, with respect to a 10 percent change in the price of a commodity, ceteris paribus.

D. Incremental Hedge Rule

7. If both the current and desirable situation are estimated through the above analyses, the next task is to undertake hedging activities. However, some instruments may not be currently available for achieving the desired situation. In this case, the above analyses should be made to reveal the second best way. Assume that the only instrument currently available for Country P is DM/U.S.$ currency swaps and A$/U.S.$ currency swaps, and that the A$/U.S.$ currency swap market is not liquid enough to hedge all the A$ risk. In this case, the risk analysis should be again carried out to estimate the appropriate amount of the DM/U.S.$ and A$/U.S.$ currency swap transactions to achieve the second best situation under the circumstances. The analyses should also provide the risk exposure after the swap transactions so that the country can prepare for future hedging

transactions. Also some of the commodity price risks can be managed by changing currency composition of the external debt, since commodity prices and some currencies tend to move inversely. The same kind of incremental hedge and risk measurement procedure can be undertaken in this case.

D. Important Rules for an Effective Asset and Liability Management

19. Two important rules to achieve an effective asset and liability management are: the incremental hedge rule and the flexible hedge rule.[8]/

20. Incremental Hedge Rule. It should be noted that most countries undertake risk-hedging activities incrementally. Often adequate hedging instruments to achieve a desired asset/liability structure are not available to developing countries. Even if the instruments are available, the market for these instruments may not be very active. In this case, asset and liability management activities should aim to move risk exposure toward the best possible situation. In addition to a risk analysis that derives the desirable asset/liability structure, it is important to analyze the constraints on hedging transactions to reveal the risk structure that is best attainable under the circumstances (see Box I). In addition, the risk analysis should include each of the major line items (major components of assets and liabilities). Identifying major contributors to risk enables decisionmakers to carry out incremental hedging transactions in individual items with financial instruments currently available in the markets.

21. Flexible Hedge Rule. Because there is no perfect asset and liability management model to measure risk exposure, past estimates of risk exposure may turn out to be incorrect and hedging activities already in place may become obsolete or even harmful. For this reason, flexibility in modifying or reversing hedging transactions is very important. On this point, modern techniques using such instruments as futures and swaps have a significant advantage[9]/ over conventional techniques including adjustments of

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[8]/ See Toevs and Haney (1986).

[9]/ Flexibility of modern financial instruments is discussed in the next chapter.

the currency composition and maturity structure of external debt.

III. Modern Financial Tools for Risk Management

22. This chapter explains basics of financial instruments for risk management. Because understanding characteristics and mechanisms of these instruments is very important for carrying out risk management activities, the chapter attempts to provide an introductory guide to these financial instruments. The chapter also serves as a basis for the next chapter that describes actual examples of risk management in developing countries.

23. There are three general categories of risk management instruments: (1) self-insurance instruments; (2) third-party insurance instruments; and (3) other instruments.[10]/ The first category includes commodity stabilization schemes (for instance, buffer-stock and buffer-fund schemes) and export diversification. The second category includes such financial market instruments as futures, forward contracts, options, and swaps. In addition, commodity-linked instruments that combine risk management and finance have recently been added to the field of commodity price risk management. The third category includes all other schemes, including international commodity agreements and compensatory financing schemes (for instance, Stabex of the EEC and CCFF of the IMF).[11]/

24. The paper focuses on the second category, modern financial

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[10]/ Priovolos (1987).

[11]/ Stabex is a compensatory financing scheme provided by the European Economic Community for their trade partners. Financial support is provided, mainly as grants, for a country which has experienced a shortfall in its export earnings from some agricultural commodities. The Compensatory and Contingency Financing Facility (CCFF) is provided by the International Monetary Fund for its member countries. It covers a broader area of balance-of-payments items (total export earnings and cost of cereal imports) than Stabex, but requires stricter repayment conditions (e.g. within 3-5 year period, irrespective of the balance-of-payments position).

instruments.[12]/ In this chapter, Part A gives a description of forward and futures contracts, options, and swaps, as well as examples of simple risk-hedging activities with these instruments. Part B looks at instruments for hedging commodity-price risk, especially commodity swaps and commodity-linked financing schemes. The importance of these instruments in risk management is reviewed at the end of the chapter. Table 3 gives a quick overview of these instruments.

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[12]/ This is not to say one category is more effective in managing risks than the others. They may complement each other. For example, the short- and medium-term use of financial instruments may complement export diversification that has a long time horizon.

Table 3

An Overview of Financial Instruments

(1) Financial Instruments in General

Instruments	Description	Characteristics
Forward	- An agreement to purchase or sell a given asset at a future date at a preset price. - Transactions are made mostly through brokers by phone and telex. - A typical use is for locking-in a future price.	- No cash transfer is needed at the beginning. Cash transfer occurs only at maturity. - Credit risk is involved. - Tailor-made contracts are available for specific hedging needs. - Contracts are available primarily for short-term maturities (up to one year).
Futures	- An agreement to purchase or sell a given asset at a future date at a preset price. - Transactions are made in formal exchanges through clearinghouse systems. - Contract terms (amounts, grades, delivery dates, etc.) are highly standardized. - Profits and losses are settled daily, requiring daily cash flows. - Margin (collateral) money is required at the beginning. - A typical use is for locking-in a future price.	- Initial cash transfer is required for margin money. - Daily cash transfers are necessary. - Credit risk is minimal. - Tailor-made contracts are not available. - Contracts are available primarily for short-term maturities (up to one year). - Markets are more active than forward markets for some contracts. - An original position can be closed or reversed easily and quickly.
Option	- The right to purchase or sell a certain asset at a preset price on (or before) a specified date. - Transactions are made both through brokers by phone and telex and in formal exchanges. - A typical use is for setting a ceiling or floor for prices.	- A buyer of an option contract can limit the maximum loss, but keep an opportunity to take advantage of favorable price movements. - A buyer has to pay a premium (cost of option) up-front. - A buyer faces a seller's credit risk. (A buyer has the right; a seller has the obligation.) - Tailor-made contracts are available for specific hedging needs. - Contracts are available primarily for short-term maturities (up to one year).
Swap	- An agreement to exchange specified cash flows at fixed intervals. - A series of forward contracts lined up on a schedule. - Transactions are made through brokers by phone and telex. - A typical use is for locking-in future prices for a long period.	- No cash transfer is needed at the beginning. - Credit risk is involved. - Tailor-made contracts are available for specific hedging needs. - Contracts are available for medium- and long-term maturities (one to ten years).

Table 3 (continued)

An Overview of Financial Instruments

(2) Commodity-Linked Instruments

Instruments	Description	Characteristics
Commodity Swap	- A swap contract on a certain commodity. An agreement to pay a pre-fixed amount of cash in exchange for a variable amount of cash at fixed intervals, or vice versa. A variable amount of cash is determined by the market price for a set quantity of a commodity. A fixed amount is based on a fixed price for the same quantity of the commodity. - Contracts are provided by international banks. - A typical use is for locking-in a price of a commodity for medium- and long-term.	- No deliveries of physical commodities are involved. Transactions are made as purely financial, as the other swap contracts (see the swap section above for characteristics of swap contracts in general). - The markets are not very active.
Commodity-Linked Loan	- A loan in which interest and/or repayment amount are linked to the market price of a certain commodity. - A loan can be viewed as a combination of a conventional fixed-rate loan and a commodity swap contract. - These loans are provided by international banks.	- A loan can be regarded as effectively denominated in a commodity. - Credit risk of the loan is lower than that of a conventional loan, if used by a commodity producer. A producer can repay the loan even if the price of the commodity fell significantly.
Commodity-Linked Bond	- (Forward-type) A bond in which coupons and/or principal are linked to the market price of a certain commodity. - (Option-type) A bond to which the right to buy or sell a certain commodity at a preset price is attached. - These bonds are underwritten by international banks.	- (Forward-type) Characteristics are similar to commodity-linked loans. - (Option-type) This type is often useful for commodity producers to reduce the cost of financing. - The bonds have been issued primarily on gold and oil. some are available for silver, copper, and nickel.

TABLE 4

Liquidity of Markets
(Forward, Futures, Options, and Swaps)

		Currency	Interest Rate	Commodity
Forward	Short-Term	A	A	B
	Long-Term	C	C	C
Futures	Short-Term	B	A	B
	Long-Term	C	C	C
Options	Short-Term	B	A	C
	Long-Term	C	B	C
Swaps	Short-Term	C	A	C
	Long-Term	B	B	C

A -- Highly Liquid 1/
B -- Moderately Liquid
C -- Not Liquid

1/ Here, a "liquid" market means the market where a counter-party of a transaction of the instrument can be found easily and the transaction can be made quickly without changing the price of the instrument considerably. In a highly liquid market, the transaction of large quantity can be completed in a matter of minutes.

A. Forward, Futures, Options, and Swap Contracts

(1) Forward Contacts

25. A forward contract is an agreement to purchase or sell a given asset at a future date at a preset price. At maturity, if the actual price (spot price) is higher than the contracted price, the forward buyer makes a profit. If the price is lower, the buyer suffers a loss. The seller of a forward contract agrees to deliver a given asset to a buyer (or settle in cash) at a preset price. In this case the payoff is the opposite of a buyer of the forward contract.

26. Forward contracts are often used to hedge the risk of holding a certain asset or liability. This activity, called a "forward cover," involves the execution of a set of (reverse) transactions in both the spot and the forward market: if one holds (or purchases in the spot market) a certain asset, one sells the same amount of that asset in the forward market at a pre-specified price. When the forward contract matures, one sells that asset at the specified price. This enables the owner to fix the amount of revenue from the future sale of the asset at the time the contract is made, "locking-in" the price.

27. For example, assume that an exporter's major market is in West Germany and export revenues are denominated in deutsche marks (DM). The exporter has taken out U.S.$ 1 million loan from a U.S. bank to be repaid in six months when the customer pays DM 2 million for the delivered goods. The current exchange rate is 2 deutsche marks to the dollar. If the deutsche mark depreciates in the next six months (say, to 2.2 deutsche marks to the dollar), the exporter will not be able to repay the loan. The exporter can hedge the

exchange rate risk with a forward contract. The current deutsche mark/dollar forward rate for the six-month contract is DM 2.0/$ (two deutsche marks per dollar).[13]/ The exporter purchases a forward contract to sell the DM 2 million for U.S.$ 1 million at the end of the six months, thus locking-in the amount of the export revenue at today's forward exchange rate.

28. This shows two important characteristics of the forward contract (in addition to its use as a hedging instrument). First, no cash transfer occurs up-front. The exporter is obligated to deliver the deutsche marks at maturity, but pays no money up-front except for transaction fees. Second, forward contracts involve a credit risk. Suppose the counter-party of the forward transaction fails to deliver the U.S. dollars at maturity. Although the exporter can then buy U.S. dollars for the deutsche marks in the spot market, the whole purpose of hedging fails. Since a forward contract is an agreement between two parties, credit risk or default risk has to be considered.

29. Forward markets for major currencies are liquid and efficient for transactions up to a maturity of one year. (For an overview of liquidity of forward, futures, options, and swaps for currencies, interest rates, and commodities, see Table 4.) For periods beyond one year, however, currency swaps can serve the same role.[14]/ Forward markets for major currencies have no formal exchanges. Transactions are made through brokers and dealers by phone and telex. This is also true for interest rate forward markets.

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[13]/ The spot and forward rates are assumed to be the same here for convenience and simplicity. Pricing theories and mechanisms of the financial instruments are not discussed here. There are numerous publication on these issues. Cox and Rubinstein (1985), Grabbe (1986) and Figlewski (1986) contains a good description with respect to both theory and practice, for instance.

[14]/ See the description of currency swaps below.

30. Forward contracts for international interest rates are known as forward rate agreements (FRAs). Like currency forwards, markets for FRAs are liquid up to a year, and beyond that, interest rate swaps play a major role in interest rate risk hedging. The mechanism of FRAs is similar to currency forward contracts: two parties agree to pay or receive a specified interest rate on a certain amount of money for the future period. For example, in a "3 x 6" FRA[15]/ on U.S.$ 1 million at six percent, two parties agree to receive or pay U.S.$ 15,000 (U.S.$ 1,000,000 x 6% x 3/12) in interest for a period of three months starting three months from now.[16]/

31. Forward markets for commodities are less liquid than currency and interest rate markets. The London Metal Exchange is one of the largest forward markets for commodities: aluminum, copper, lead, nickel, and zinc are traded on three-month maturities. Transactions are also made through brokers and dealers by phone and telex, as in currency and interest rate forward and swap trading.

(2) Futures Contracts

32. Futures contracts are similar to forward contracts: the buyer of a futures contract agrees to purchase a specified asset at a specified price on a specified date. But futures contracts differ significantly in four ways. First, contract terms (amounts, grades, delivery dates, and so on) are

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[15]/ The expression "3 x 6" (pronounced "three against six") means the period starting three months from now and ending six months from now.

[16]/ The actual market practice for settlements is different from that in this simplified case. In actual practice, two parties pay or receive the amount which is the difference between a FRA rate (six percent) and a reference rate (LIBOR) at the beginning of the agreed period (three months from now), discounted by a three-month interest rate to reflect present value. Nonetheless, the financial effects are the same.

standardized in futures contracts (see Table 5 for examples of contract specifications). Second, transactions are handled only by organized exchanges through clearinghouse systems. Third, profits and losses in trades are settled daily.[17]/ Fourth, futures contracts require depositing a small amount of "margin" money in the exchange as collateral. Through these arrangements, futures contracts significantly reduce the credit or default risk entailed in forward transactions. Liquidity has also improved because of the standardization of contracts.

33. Futures contracts cover the same hedging activities as forward contracts. For instance, in the earlier example, the exporter can sell deutsche mark futures contracts instead of purchasing the dollars for the deutsche marks through a forward contract. The size of a deutsche mark futures contract traded in the Chicago Mercantile Exchange is DM 125,000. To hedge the DM 2 million revenue, the exporter needs 16 futures contracts (DM 125,000 x 16 = DM 2 million), which mature in 6 months.[18]/ The price of the futures contract is quoted as $ 0.5000/DM (currency futures prices are quoted in dollars against another currency). Six months later, the gain or a loss in the deutsche mark export revenue arising from changes in the exchange rate is offset by the cumulative loss or gain in the futures contracts. The major differences from forward contracts are: first, gains and losses are settled

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[17]/ A futures contract is "marked to market" every day, using the closing price of the day ("settlement price"). Profit or loss is calculated by using the settlement price, and the profit or loss is settled with clearing houses daily. This prohibits one from carrying over a huge unrealized loss over a long period and thus reduces the risk of default.

[18]/ Delivery dates of a futures contract are standardized in the contract specification to fall on a day in several months of the year. Here, the delivery date is assumed to coincide with the timing of the export revenue for simplicity.

TABLE 5

Examples of Specifications for Futures Contracts
(Eurodollar Futures and Gold Futures)

Eurodollar Futures (The Chicago Mercantile Exchange1/)

Contract size:	U.S.$ 1 million
Price quotation:	Quoted in terms of a price index (100 minus rate of interest).2/
Settlement:	Settlement is in cash. The final settlement price at maturity is determined according to the London Interbank Offered Rate (LIBOR) on three-month eurodollar time deposits prevailing on the last day of trading.
Delivery month:	March, June, September, and December.3/
Last day of trading:	Second London business day prior to the third Wednesday of the delivery month.
Minimum price change:	1/100 of one percentage point.4/
Daily price limit:	No limit

1/ Eurodollar futures contracts are also traded on the Singapore International Monetary Exchange (SIMEX), the London International Financial Futures Exchange (LIFFE), and the Tokyo International Financial Futures Exchange (TIFFE). The same contract specification is applied, except for some minor differences.

2/ For example, the price index is quoted as 91.25 for a 8.75% interest rate.

3/ The contracts maturing in each of these months are available up to 35 months out.

4/ This means that the minimum price change in the price index is 0.01.

Table 5 (continued)

Gold Futures (The Commodity Exchange, New York)

Contract size:	100 troy ounces
Price quotation:	Quoted in dollars per troy ounce.1/
Settlement:	Settlement is in physical delivery.
Deliverable grade:	Refined gold, assaying not less than 995 fineness, cast either in one bar, or in three one-kilogram bars and bearing a serial number and stamp of a refiner approved and listed by the Commodity Exchange, New York.
Delivery month:	The current month, the next two months, and February, April, June, August, October, and December.2/
Last day of trading:	Third to the last business day of delivery month.
Minimum price change:	Price changes are registered in multiples of ten cents per troy ounce.1/
Daily price limit:	Ten dollars per troy ounce above or below the closing price of the preceding business day. Price limits do not apply to prices for the current delivery month.

1/ For example, the price is quoted as 400.00 for $ 400, then, 400.10, 400.20, 400.30, and so on.

2/ The contracts maturing in each of these months are available up to 23 months out.

TABLE 6

Selected Commodity Futures Contracts1/

Commodity	Exchange	Contract Size	Open Interest2/
Cocoa	CSCE3/	10 metric tons	49,482
Coffee	CSCE	37,500 lbs.	31,016
Copper	COMEX	25,000 lbs.	32,848
Corn	CBT	5,000 bus.	170,404
Cotton	CTN	50,000 lbs.	44,467
Crude Oil	NYMEX	1,000 bbls.	262,959
Gold	COMEX	100 troy oz.	143,815
Silver	COMEX	5,000 troy oz.	88,700
Soybeans	CBT	5,000 bus.	100,617
Sugar	CSCE	112,000 lbs.	167,624
Wheat4/	CBT	5,000 bus.	52,486
	KC	5,000 bus.	134,705
	MPLS	5,000 bus.	9,970

1/ Relatively liquid futures contracts traded in the U.S. exchanges which may be relevant to the developing countries.

2/ The number of contracts outstanding as of December 9, 1989.

3/ Exchange Abbreviations
- CBT : Chicago Board of Trade
- COMEX: Commodity Exchange, New York
- CSCE : Coffee, Sugar, and Cocoa Exchange, New York
- CTN : New York Cotton Exchange
- KC : Kansas City Board of Trade
- MPLS : Minneapolis Grain Exchange
- NYMEX: New York Mercantile Exchange

4/ Wheat futures contracts on the CBT, the KC and the MPLS differ in terms of deliverable grades of wheat.

daily, requiring transferring cash to and from the exchange almost every day. Second, the exporter has to deposit some margin money in the exchange. Third, credit risks in futures transactions are significantly reduced.

34. Futures contracts are available for major currencies, interest rates, and commodities. For currencies, contracts are available for Australian dollars, British pounds, Canadian dollars, deutsche marks, French francs, Japanese yen, Swiss francs, and ECUs, all against the U.S. dollar. Major interest rate futures contracts include: U.S. Treasury bills, Treasury notes and bonds, mortgage-backed securities, British gilts, and Eurodollar, Euromark, Eurosterling, and Euroyen deposits. Commodity contracts are available for gold, silver, and platinum, and such industrial commodities as aluminum, copper, lead, nickel, heating oil, propane, gasoline, and crude oil. Numerous contracts are also available for agricultural commodities. (A list of selected commodity futures contracts traded in the U.S. exchanges is presented in Table 6.)

(3) Option Contracts

35. An option is the right to purchase or sell a certain asset at a preset price on (or before) a specified date. A buyer of the option owns the right to buy or sell and a seller (or "writer") of the option gives the right to a buyer. A number of technical terms are involved in options transactions:

- If an option gives the right to buy, it is a "call" option: if an option gives the right to sell, it is a "put" option;
- The asset on which the option is written is the "underlying" asset;
- The price at which a buyer of the option can buy or sell the

underlying asset is called the "strike" or "exercise" price;

- If the right to buy or sell is exercised by the buyer, the option is "exercised;"
- The date on (or before) which the buyer can buy or sell the underlying asset is called the "maturity" or "expiration;"
- An option that can only be exercised on the expiration date is called a "European" option: one that can be exercised either on or before the expiration date is an "American" option;
- The price of the option is called a "premium." The buyer pays the premium to the seller at the time of contracting.

36. In the earlier example, the exporter can hedge by buying a call option on U.S. dollars against deutsche marks (or, equivalently, buying a put option on deutsche marks), instead of using forward or futures contracts.[19]/ Suppose the exporter purchases a European put option on DM 2 million with a strike price of DM 2.0/$ and a maturity of six months. The premium of this option is quoted as 1 percent of the contracted amount: 1 percent of the DM 2 million, or DM 20,000, which is $ 10,000 at the current spot rate of DM 2.0/$. If the deutsche mark depreciates to DM 3.0/$, the exporter will exercise this option to sell the DM 2 million at DM 2.0/$. and receive U.S.$ 1 million. If the deutsche mark appreciates to DM 1.0/$, the exporter will instead sell the DM 2 million in the spot market for U.S.$ 2 million, making extra U.S.$ 1 million. If the deutsche mark is unchanged, the exporter will sell the DM 2 million for U.S.$ 1 million by either exercising the option or trading in the

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[19]/ A call option on U.S. dollars (the right to buy U.S. dollars for DMs) is a put option on DMs (the right to sell DMs for U.S. dollars). They are equivalent, except for the currency that is the underlying asset.

spot market. The DM 20,000 premium will have been paid at the beginning in any case.

37. Compared to forward and futures contracts, options have three interesting characteristics. First, unlike forward or futures contracts in which the future price is locked-in, options contracts limit the maximum loss (equal to the premium paid up-front), but leave an opportunity to take advantage of favorable price movements. Second, the buyer has to pay the premium up-front. This often requires a significant amount of cash at the purchase of options. Third, while the buyer of an option faces a credit or default risk by the counter-party, the seller does not. It is the seller who is liable, not the buyer.

38. There are liquid markets for options on currencies with short-term maturities. These options are traded both informally, as in the case of forwards, and in formal exchanges, as futures. Options on currency futures are also available in some exchanges (for instance, the Chicago Mercantile Exchange and the Singapore International Monetary Exchange). Long-term options on currencies are not actively traded.

39. Interest rate options also have liquid markets. There are two forms: options on interest rate-bearing securities (such as U.S. Treasury bonds) and options on interest rates themselves. The latter are known as "caps" and "floors," which are, in effect, a series of options maturing on different dates. Caps are call options and floors are put options on interest rates. For example, a cap for a five-year period on a U.S. dollar six-month interest rate with a strike price of 10 percent gives the buyer of this cap the right to exercise the option every six months up to five years from now (twice a year x five years = 10 options). The buyer receives the amount equal

to the contracted amount of dollars multiplied by the difference between the current interest rate and the strike price of 10 percent, if the six-month rate is higher than 10 percent.

40. For commodities, options on physical commodities and options on commodity futures are available only for short-term maturities (four to five months). The most actively traded contracts are on gold, silver, and oil. Long-term options are traded primarily on gold, silver, and oil: but the markets are not very active.

(4) Swap Contracts

41. A swap contract is an agreement to exchange, or swap, specified cash flows at fixed intervals. This means that a swap contract can be viewed as a series of forward contracts lined up on a schedule. For example, one party delivers a specified amount of a currency in exchange for another currency on every date specified in the currency swap. Returning to the example mentioned earlier, assume that the exporter and the German company agree upon a long-term export contract in which the German company pays DM 2 million for goods every six months over the next five years. Assume also that the exporter wants to lock-in the dollar value of these revenues now. The exporter now enters into a currency swap contract with a U.S. bank. The U.S. bank agrees to pay U.S.$ 1 million every six months for the next five years to the exporter: the exporter agrees to pay DM 2 million on the same dates when the bank pays the dollars over the five years. Thus, the currency swap contract is, in effect, a series of 10 forward contracts lined up over the next five years. Table 7 shows cash flows in this currency swap.

42. Swap contracts, therefore, have the same characteristics as

Table 7

Currency Swap Cash Flows and Exporter's Payoff

Period	(Long-Term Contract) GC ⟶ EX	(Currency Swap) EX ⟶ US	(Currency Swap) US ⟶ EX	EX Payoff
Year 1-1	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
1-2	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
Year 2-1	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
2-2	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
Year 3-1	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
3-2	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
Year 4-1	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
4-2	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
Year 5-1	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.
5-2	DM 2 mil.	DM 2 mil.	US$ 1 mil.	US$ 1 mil.

GC: German Company
EX: Exporter
US: U.S. Commercial Bank

forward contracts: no cash is required at the beginning[20]/ and there is a credit risk. Swap contracts, however, are available for longer maturity (three to ten years).

43. Generally, in interest rate swaps, two parties agree to exchange floating interest and fixed interest payments. Consider a simple example of an interest rate swap agreement.

Notional Amount: **(Contracted Amount)**	100 million yen
Floating Rate Payor: **(Fixed Rate Receiver)**	Party A
Fixed Rate Payor: **(Floating Rate Receiver)**	Party B
Fixed Rate:	5.25 percent
Floating Rate:	Yen six-month LIBOR quoted by the British Bankers Association.
Tenor:	Five years commencing August 28, 1989, with semiannual payments.
Floating Rate Fixing:	Every six months.
Interest Payment:	At the end of each six-month period.
Interest Calculation:	Notional amount times fixed or floating rate, multiplied by the number of actual days in the period divided by 360 (for example, Yen 100,000,000 x 5.25% x 184 days / 360 days = Yen 2,683,333).
Settlement:	Netting-out [21]/

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[20]/ Some designs of currency swaps involve exchanges of cash at the beginning and/or at the end of a contract life to accommodate specific needs of users. However, this does not alter the essential nature of swaps mentioned in the text, since these designs can be regarded as a combination of a plain swap and cash flow transactions at the beginning and/or at the end.

[21]/ Instead of exchanging fixed and floating interest payments, two parties can agree on settlement by netting-out. In this case, the floating rate payor receives the difference between the fixed and the floating interests, if the

Table 8

Interest Rate Swap Cash Flows

Notional Amount: Yen 100,000,000

Period	1/ Days in Period	2/ Yen LIBOR	(Interest Rate Swap)3/ A ⟹ B (Floating)	B ⟹ A (Fixed)	Fixed Rate	(Settlements by "Netting-Out")4/ A ⟹ B	B ⟹ A
Year 1-1	184	5.00%	2,555,556	2,683,333	5.25%	0	127,777
1-2	181	4.75%	2,388,194	2,639,583	5.25%	0	251,389
Year 2-1	184	4.50%	2,300,000	2,683,333	5.25%	0	383,333
2-2	181	4.00%	2,011,111	2,639,583	5.25%	0	628,472
Year 3-1	184	4.50%	2,300,000	2,683,333	5.25%	0	383,333
3-2	182	5.00%	2,527,778	2,654,167	5.25%	0	126,389
Year 4-1	184	5.25%	2,683,333	2,683,333	5.25%	0	0
4-2	181	5.75%	2,890,972	2,639,583	5.25%	251,389	0
Year 5-1	184	6.50%	3,322,222	2,683,333	5.25%	638,889	0
5-2	181	6.25%	3,142,361	2,639,583	5.25%	502,778	0

1/ Actual days in the half year period.

2/ Floating rates quoted by the British Banker Association on every interest rate fixing date. The hypothetical rates for the next five years are randomly created here.

3/ The amount of each interest payment is calculated by the following formula: notional amount x interest rate x actual days / 360. For example, the floating interest payment for the first six month is calculated as follows:

Yen 100,000,000 x 5.00% x 184 / 360 = Yen 2,555,556.

4/ Cash flows if the "netting-out" style is used for settlements.

Table 8 shows cash flows for the next five years in this swap.

44. Commodity swap contracts are the most recent development in the swap markets. The idea is the same as in currency swaps and interest rate swaps: two parties agree to exchange floating prices and fixed prices on a certain commodity. More detailed explanations of commodity swaps are in the next section.

45. Markets for both currency and interest rate swaps have good liquidity. The maturities can generally be extended up to 10 years. Transactions are made through traders and brokers. Swaps often accompany bond issues in Euromarkets.

46. Markets for commodity swaps are not yet active but have been growing. Swaps are available primarily for gold, silver, and crude oil; copper, aluminum, nickel, zinc, and jet fuel can also be swapped, but the markets are thinner.

B. Commodity Risk Management Instruments

(1) Commodity Swaps

47. Commodity swaps are basically the same as currency and interest rate swaps. But a commodity swap is not exactly a series of commodity forward contracts, unlike a currency or an interest rate swap: it does not involve deliveries of physical commodities.[22]/ Transactions are made as purely

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floating rate is lower than the fixed rate. If the floating rate is higher than the fixed rate, the floating rate payor pays the difference.

[22]/ However, it should be noted that the economic consequences are approximately equal to those of a series of forward contracts.

financial, as shown in the following example:

48. Assume that an oil producer wants to lock-in the price of oil exports for the next five years, and will export one million barrels a year. The producer arranges the following commodity swap agreement with a commercial bank.

Commodity:	Oil
Amount:	The U.S.dollar equivalent of one million barrels of oil every year.
Fixed Price Payor:	Commercial bank
Floating Price Payor:	Oil producer
Tenor:	Five years, with annual payments
Fixed Price:	US$ 17.00 per barrel
Floating Price:	The average daily closing spot price of North Sea Brent oil over the year preceding each payment date.
Settlement:	Netting-out[23]/

In this example, the oil producer sells oil to the third party from time to time at the spot price, but the revenues for the next five years are effectively fixed at a U.S.$ 17.00 price (see Table 9).

49. Note that oil producer has hedged its cash flows from oil sales. Even if the price of oil declines to, say, U.S. $ 8.00, the producer's total revenues stay the same. This reduced risk may improve the producer's credit rating and lower the cost of financing working capital or provide access to new lenders. This point will be clear in the following example of commodity-linked loans.

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[23]/ See footnote 21.

Table 9

Commodity Swap and Producer's Payoff

Amount: The U.S. dollar equivalent of 1 million barrels of oil.

Period	1/ Oil Price	2/ Export Revenue	(Commodity Swap)3/ OP ==> CB (Floating)	CB ==> OP (Fixed)	OP's Payoff	(Settlements by "Netting-Out")4/ OP ==> CB	CB ==> OP
Year 1	18.00	$ 18 mil	$ 18 mil	$ 17 mill	$ 17 mil	$ 1 mil	0
Year 2	16.00	$ 16 mil	$ 16 mil	$ 17 mill	$ 17 mil	0	$ 1 mil
Year 3	12.00	$ 12 mil	$ 12 mil	$ 17 mill	$ 17 mil	0	$ 5 mil
Year 4	10.00	$ 10 mil	$ 10 mil	$ 17 mill	$ 17 mil	0	$ 7 mil
Year 5	8.00	$ 8 mil	$ 8 mil	$ 17 mill	$ 17 mil	0	$ 9 mil

OP: Oil Producer/Exporter
CB: Commercial Bank

1/ The hypothetical oil price per barrel for the next five years.

2/ Producer's revenue from the export of 1 million barrels of oil at the spot price.

3/ The floating payment amount is calculated by multiplying the 1 million barrels by the floating oil price. The fixed payment is based on the fixed price of $ 17.00 per barrel.

4/ Cash Flows of the oil swap if the "netting-out" style is used for settlements.

(2) Commodity-Linked Loans

50. In these loans, interest and/or repayment amounts are linked to the price of a certain commodity or to an index of commodity price(s). In a popular form of commodity-linked loans, interest and principal are paid in equal installments, the amount of which is linked to the cash equivalent of a certain quantity of a commodity. In another popular case, only the interest payments are linked to a commodity price. In any case, a commodity-linked loan combines a conventional bank loan with a commodity swap. A commodity-linked loan by itself, or a conventional bank loan and a commodity swap will both yield the same financial results,[24]/ as seen in the following example:

51. A copper producer requires a U.S.$ 1 million capital investment to increase production capacity. But the success of the project depends on future copper prices. Copper is currently U.S.$ 1.00 per pound. If the expansion is financed by a bank loan, and copper prices decline, it will affect the producer's ability to repay the loan. The producer takes out the following copper-linked loan with a French commercial bank.

Lender:	French bank
Borrower:	Copper producer
Commodity:	Copper
Principal Amount:	U.S.$ 1 million (equivalent to the value of 1 million pounds of copper at the current price).
Tenor:	Five years, with semiannual installments.
Repayment Schedule:	Ten semiannual payments of the U.S.$ equivalent of 130,000 pounds of copper (multiplied by the reference price).

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[24]/ Legal implications are, of course, different between the two.

Reference Price:	**The average daily closing cash copper price in the London Metal Exchange over the six months preceding each repayment date.**

The loan can be repaid regardless of the copper price over the next five years since the loan is effectively denominated in copper (see Table 10).

52. The same result can be achieved with a conventional bank loan and a copper swap. The producer borrows U.S.$ 1 million from a U.S. commercial bank, to be repaid in 10 semiannual installments of U.S.$ 130,000 over the next five years.[25]/ A parallel copper swap with the French bank covers:

Commodity:	Copper
Amount:	The U.S. dollar equivalent of 130,000 pounds of copper (equal to U.S.$ 130,000 at the current price), semiannually
Fixed Price Payor:	French bank
Floating Price Payor:	Copper producer
Tenor:	Five years, with semiannual payments
Fixed Price:	U.S.$ 1.00 per pound
Floating Price:	The average daily closing cash copper price in the London Metal Exchange over the six months preceding each repayment date.
Fixed Payment Amount:	U.S.$ 130,000 (U.S.$ 1.00 x 130,000 lb.), semiannually
Floating Payment Amount:	The U.S. dollar equivalent of 130,000 pounds of copper multiplied by the floating price, semiannually.

With the U.S.$ 130,000 received from the French bank through the copper swap, the copper producer repays the loan semiannually. The floating amount is paid

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[25]/ This means that the loan bears a fixed interest rate of approximately 10.42 percent per annum.

Table 10

Copper-Linked Loan Repayment Cash Flows

Principal Amount: U.S.$ 1 million (equivalent to the value of 1 million pounds of copper at the current price).

Period	1/ Copper Price	Copper-Linked Loan 2/ Repayment CP ===> FB
Year 1-1	1.05	$ 136,500
1-2	0.92	$ 119,600
Year 2-1	0.88	$ 114,400
2-2	0.77	$ 100,100
Year 3-1	0.90	$ 117,000
3-2	1.02	$ 132,600
Year 4-1	1.12	$ 145,600
4-2	1.23	$ 159,900
Year 5-1	1.07	$ 139,100
5-2	0.91	$ 118,300

CP: Copper Producer
FB: French Bank

1/ The hypothetical copper price per pound for the next five years.

2/ The amount of each repayment is calculated by multiplying 130,000 pounds by the copper price for the period.

Table 11

Conventional Loan Plus Commodity Swap

Cash Flows

Period	Conventional Loan1/ (Principal amount: U.S.$ 1 million) CP ⟹ US Repayment	Copper Swap (Notional Amount: 130,000 pounds of copper) 2/ Copper Price	CP ⟹ FB (Floating)	FB ⟹ CP (Fixed)	Fixed Price	Net Payment3/ of the Copper Producer After Copper Swap
Year 1-1	$ 130,000	1.05	136,500	130,000	1.00	136,500
1-2	$ 130,000	0.92	119,600	130,000	1.00	119,600
Year 2-1	$ 130,000	0.88	114,400	130,000	1.00	114,400
2-2	$ 130,000	0.77	100,100	130,000	1.00	100,100
Year 3-1	$ 130,000	0.90	117,000	130,000	1.00	117,000
3-2	$ 130,000	1.02	132,600	130,000	1.00	132,600
Year 4-1	$ 130,000	1.12	145,600	130,000	1.00	145,600
4-2	$ 130,000	1.23	159,900	130,000	1.00	159,900
Year 5-1	$ 130,000	1.07	139,100	130,000	1.00	139,100
5-2	$ 130,000	0.91	118,300	130,000	1.00	118,300
	(A)		(B)	(C)		(D)

CP: Copper Producer
US: U.S. Commercial Bank
FB: French Bank

1/ The internal rate of return on this loan is approximately 10.42%.

2/ The hypothetical copper price per pound for the next five years.

3/ The net payment: (D) = (A) + (B) - (C). Note that the net results are the same as those of the copper-linked loan. Please refer to Table 10.

to the French Bank in exchange for the U.S.$ 130,000. The financial result is the same as with the copper-linked loan (see Table 11).

(3) Commodity Bonds

53. Commodity bonds can be either a forward type or an option type. In the former, principal and/or coupons are linked to the price of a certain commodity or to an index of commodity price(s). If only the principal payment (redemption value) is linked to a commodity price, this bond is, in effect, a security in which a conventional bond and a commodity forward contract are combined. If the coupon payments are also linked to a commodity price, the bond is a combination of a conventional bond and a commodity swap. Note that a commodity-linked loan is a combination of a conventional loan and a commodity swap contract. The same principle is applicable to this type of commodity bond. The forward type bonds are often issued by commodity producers for risk-hedging.

54. The second type is a bond that combines a conventional bond with commodity options. In this case, a holder of the bond owns the right to buy or sell a certain commodity at a certain exercise price in addition to a conventional bond. The option-type bonds are often used to lower the cost of financing (lower coupons) by attaching long-term options written on a commodity.

55. Consider an example in which a gold-producing developing country issues forward-type bonds linked to the gold price in the Eurobond market to raise U.S.$ 50 million. Assume the current price of gold is U.S.$ 400 per troy ounce.

Issuer:	Gold producing country
Face Value of a Bond:	U.S.$ 1,000
Amount:	U.S.$ 50 million (U.S.$1,000 x 50,000 bonds).
Issue Price:	U.S.$ 1,000 per bond
Maturity:	Ten years
Coupon Payment:	Annual payments of the dollar equivalent of 0.25 troy ounce of gold (multiplied by the reference price) per bond.
Reference Price:	The average daily London morning fixing price of gold over the last year preceding each coupon payment date.
Redemption:	The dollar equivalent of 2.5 troy ounces of gold (multiplied by the reference price.).

The 50,000 gold bonds carrying a U.S.$ 1,000 face value are issued. Thus, 12,500 troy ounces (0.25 troy oz. x 50,000) of gold are necessary for the annual coupon payment, and 125,000 troy ounces (2.5 troy oz. x 50,000) are required for redemption. Based on the current gold price, the coupon rate of the bond is 10 percent (U.S.$ 400 x 0.25 troy oz. = U.S.$ 100, or 10 percent of the face value.).[26]/ The country can service the debt from gold exports regardless of the gold price over 10 years. Annual gold exports of 12,500 troy ounces, or approximately 390 kg. are necessary for coupon payments; 3.9 tons are required for redemption.

56. Bonds linked to commodity prices have been issued primarily on gold and oil, although some are available for silver, copper, and nickel.

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[26]/ The true yield to maturity on this bond should be calculated by using the forward rates of the gold.

C. Importance of Financial Instruments in Risk Management

57. Forward, futures, option, and swap contracts are important for risk management activities in three respects. First, these instruments give governments flexible ways to hedge. Imagine that a country carries floating-rate debt with a five year maturity, but wants to hedge against the risk of rising interest rates only for the next nine months. It is very difficult to find other ways than using futures or forward contracts for this particular sort of task. These instruments are specifically designed to manage the risk exposure of the underlying assets or liabilities. The risk characteristics of the underlying asset (or liability) can be effectively altered by contracting these instruments, without either renegotiating the terms and conditions of the existing debt or increasing the reserve holding at the central bank. In addition, a hedging activity can be terminated more quickly with these instruments, since transactions to reverse the original position can be made easily in these instruments. Second, these instruments provide active markets that would not otherwise be available for risk-hedging activities. For example, futures contracts provide active markets where short-term hedging transactions can be arranged in a matter of minutes. Swap contracts have added remarkable opportunities in long-term hedging activities that would not be available otherwise. Third, these instruments, especially options, offer an unconventional risk profile. Options provide nonlinear risk exposure: one can limit the maximum loss, but take advantage of favorable price movements. Imagine that an oil producing country wants to hedge against declining prices of oil, but wants to take advantage of rising prices. The country may not be willing to enter into a long-term sales contract at a fixed price, but may be

willing to purchase oil option contracts. Options and the other instruments enable financial institutions to provide "financial engineering" services. That is, they can use sophisticated instruments designed to fit users' specific needs. The developing countries could take advantage of financial engineering to design appropriate instruments to suit country-specific risk management needs.

58. The commodity-linked schemes provide an opportunity for better management of commodity price risks. With an appropriate design of commodity-linked schemes, developing countries can reduce the effects of external shocks and improve investment and project planning for economic development.

59. Additionally, commodity-linked schemes provide access to financial markets that would not otherwise be available. These schemes can tap a different group of investors who have specific demands for commodity-linked securities, and the improved ability to service debts improves the country's creditworthiness. This may lead to better financing terms (cheaper cost, longer-terms) on commodity-linked as well as conventional types of financing.

IV. Applying Modern Financial Techniques

A. Recent Examples in the Developing Countries

60. Some developing countries have begun to use modern financial instruments.[27]/ Below are some examples including Eurodollar futures contracts (Chile); currency and interest rate swaps (India and Thailand); currency options (India, Indonesia, and Turkey); a loan with a copper swap (Mexico); and a loan with oil options (Algeria).[28]/

(1) Hedging with Eurodollar Futures Contracts

61. Chile's Central Bank uses Eurodollar futures to manage the risk of nominal interest rate fluctuations on dollar-denominated external debt. To reduce the uncertainty of its variable interest rate debt with commercial banks, in 1988 and 1989 the bank carried out short-term hedging operations with Eurodollar futures contracts on the International Monetary Market of the Chicago Mercantile Exchange.[29]/ (See Appendix for an explanation of the Eurodollar futures contracts.)

62. Background. Chile's external debt carries considerable U.S.$ interest rate risk. As of December 1987 about 83 percent of its total U.S.$ 18 billion medium- and long-term debt consisted of variable-rate loans, mostly

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[27]/ Some major oil exporting countries, such as Saudi Arabia and U.A.E., have been active in international financial markets to manage their cash reserves. This paper does not include their activities.

[28]/ Precise pricing information is not available for some of these transactions, partly because the complete terms were not made public. While some of the data given below may not be precise, they should be regarded as reasonably accurate.

[29]/ The Treasurer's Office of the World Bank provided Financial Technical Assistance for these operations. Also see IMF, op. cit.

tied to the six-month LIBOR.[30]/ Of this amount, U.S.$ 13.8 billion is owed to commercial banks. About 90 percent of the total medium- and long-term debt is denominated in U.S. dollars. As part of the 1987 debt restructuring and financing package reached with a consortium of foreign banks, approximately U.S.$ 9 billion of debt was converted from loans tied to the six-month LIBOR to those tied to the one-year LIBOR. Interest rates were to be reset at various dates in February, March, and April 1988.

63. After the October stock market crash, the future of the U.S. economy was particularly uncertain. The Federal Reserve eased monetary policy after the crash to reestablish the confidence of financial markets by supplying ample liquidity: however, it was ready to tighten the money supply if the economy showed signs of rising inflation. (The Federal Reserve actually tightened monetary policy in March and interest rates bottomed-out in February.)[31]/ U.S. interest rates continued to rise until April 1989. During this period, Chile hedged its debt against rising interest rates with Eurodollar futures contracts.

64. Chile's Hedging Operations. The Central Bank hedged about U.S.$ 1.5 billion of Chile's U.S.$ 9 billion debt, of which the Central Bank's direct obligations amounted to U.S.$ 3.5 billion. For the February and March reset dates, the bank sold March 1988 Eurodollar futures contracts: for April 1988 it sold June 1988 futures contracts. In total, about 6,000 contracts or about U.S.$ 6 billion were sold. The size of a Eurodollar futures contract is U.S.$ 1 million and the contracts are traded for three-month interest rates. To hedge against the one-year interest rate on the U.S.$ 1.5 billion debt,

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[30]/ World Debt Tables 1989-90.

[31]/ See Table 12.

Table 12

Eurodollar Interest Rates (LIBOR)
(From September 1987 to May 1989)

Period		(Average U.S.$ LIBOR)1/ Three-Month	One-Year
1987	September	7.634	8.560
	October	8.387	8.887
	November	7.528	7.941
	December	7.977	8.185
1988	January	7.256	7.781
	February	6.836	7.250
	March	6.859	7.383
	April	7.201	7.799
	May	7.506	8.196
	June	7.736	8.304
	July	8.216	8.684
	August	8.614	9.136
	September	8.426	8.902
	October	8.634	8.816
	November	9.016	9.158
	December	9.406	9.531
1989	January	9.408	9.786
	February	9.734	10.171
	March	10.295	10.896
	April	10.169	10.616
	May	9.771	9.818

1/ Monthly average London Interbank Offered Rates on the U.S.$ loan.

approximately 6,000 contracts or U.S.$ 6 billion's worth of three-month Eurodollar futures contracts were necessary. Hedging every U.S.$ 1 million debt required U.S. 4 million Eurodollar futures (or four contracts), because a percentage point rise in one-year interest rate results in four times as much increase in interest costs of the debt as a percentage point rise in three-month interest rate (since a period covered is four times longer).[32]/

65. The sale of futures contracts was spread over more than three weeks. The Central Bank closed the position by buying back the contracts within a week of each interest reset date, for an effective LIBOR of 7.3 percent. The LIBOR would have been as high as 7.8 percent without the hedging. An initial margin of U.S.$ 1,500 per contract was required by the exchange. About U.S.$ 9 million in cash and U.S. Treasury bills was deposited for this purpose. The brokerage fee was U.S.$ 30 per contract (round trip),[33]/ or approximately U.S.$ 180,000 (0.012 percent of U.S.$ 1.5 billion).[34]/

66. Based on this operation, the Central Bank arranged another hedging operation for the interest reset in the first half of 1989. During the rest of 1988, about 14,000 March and June 89 contracts were sold to hedge the total U.S.$ 3.5 billion assumed by the Central Bank. The Central Bank closed the futures position on each interest reset date in 1989. Since interest rates rose significantly during this period, the sold futures contracts generated

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[32]/ A detailed explanation is provided in Appendix.

[33]/ "Round trip" means that the brokerage fee is charged when the sold (bought) contracts are bought (sold) back to close out the position, or when the contracts expire.

[34]/ U.S.$ 30 x 6,000 contracts = U.S.$ 180,000.

significant profits.[35]/ The futures position reportedly produced an average profit of over 60 basis points (0.6 percent) per contract, reducing the effective cost of the Central Bank's debt service by more than 10 percent.

(2) Currency and Interest Rate Swaps (India and Thailand); Currency Options (India, Indonesia, and Turkey)

67. Several developing countries have occasionally used currency/interest rate swaps and currency options. India and Thailand have been frequently reported in finance journals as users of swap schemes, while India, Indonesia, and Turkey used dual currency loans (loans with currency options).[36]/

(a) Currency and Interest Rate Swaps

68. Currency and interest rate swaps are typically used in two ways: first, to hedge an existing risk by contracting a swap, and second, to obtain a desirable liability structure by contracting new debt and a swap at the same time. For example, a country may arrange a swap in such a way that the timing of cash flows in a swap matches the payment dates on the existing asset or liability. Or, a country may borrow in one currency and enter into a swap transaction in which repayment cash flows are exchanged for another currency.

69. Thailand used both types of swaps. The Ministry of Finance has arranged with U.S. money center banks and Japanese banks to exchange floating interest payments for fixed interest payments (or fixed interest payments for

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[35]/ The sale of Eurodollar futures contracts will generate profits if interest rates rise. It will suffer losses if the rates fall.

[36]/ International Financing Review, Euromoney, and Middle East Businees Weekly (MEED), various issues.

floating interest payments). In March 1988 the ministry officials invited several U.S. commercial banks (Chase Manhattan, Citicorp, Chemical, and Security Pacific) to bid for two (seven-year) U.S. dollar fixed/floating interest swaps of about U.S.$ 70 million.[37]/ Although Thailand does not disclose its swap transactions, the country is known in the international financial community for this type of transaction.

70. Thailand also uses swaps with new borrowing. Thailand wanted to tap the deutsche mark and Swiss franc bond market, but preferred to repay part of the debt in another currency. In mid-1988, Thailand issued the first public Euro-deutsche mark bond for DM 200 million and the first public Euro-Swiss franc bond for SFr 200 million. The deutsche mark bond, managed by Commerzbank and Deutsche Bank, had a maturity of five years, with 5.75 percent annual coupon payments: the Swiss franc bond had a seven-year maturity with a 4.625 percent coupon. The deutsche mark and Swiss franc cash flows to service these bonds were partly swapped to achieve repayments effectively denominated in another currency (U.S.$). In another example the Industrial Bank of Japan provided 13 billion yen in 1988 for the Electricity Generating Authority and the Petroleum Authority of Thailand. The eight billion yen was swapped for U.S. dollars to be effectively denominated in U.S. dollars.

71. Many Indian agencies and public sector firms, such as the Industrial Development Bank of India, the Export Import Bank of India, the

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[37]/ For example, if Thailand wants to hedge an existing floating rate loan with a swap, it can contract a swap in which it pays fixed interest and receives floating interest. Let L denote LIBOR (floating rate), m denote a margin above LIBOR, and R denote a fixed interest rate on a swap. Assume that Thailand's existing floating rate loan carries an interest rate of L + m, and Thailand now contracts a swap in which it pays R and receives L. Thailand's effective interest cost becomes;

$$(L + m) - L + R = R + m.$$

Industrial Credit and Investment Corporation of India, and Air India, have used swap transactions. It is estimated that up to U.S.$ 1 billion swaps have been completed over the last two years. The recent transactions include: yen fixed interest into yen floating interest, yen fixed interest into dollar fixed, and sterling fixed interest into dollar floating interest. Most of the swaps have reportedly only applied to the interest portion of liabilities.

(b) Dual Currency Loans

72. A dual currency loan is a loan with a currency option on the principal (or a part of the principal). There are three types of dual currency loans. In the first type, a loan is made in one currency, but the lender has the right to choose, at maturity, whether to accept the principal repayment in the original or in another currency at a pre-specified exchange rate. From the viewpoint of the lender, this loan is a combination of a conventional loan and the purchase from the borrower of a currency option written on the principal payment. The second type involves a conventional loan and the sale of a currency option by the lender: the borrower has the right to choose the repayment currency at a pre-specified exchange rate. In the third type, the borrower has the right to choose the currency of the loan at the time of drawing, and has to repay in that currency.

73. Where the lender chooses the repayment currency, the risk to the borrower tends to increase rather than decline: the borrower's cost may be less because of the sale of the currency option, but the borrower is open to loss if the lender exercises the option. For example, a U.S.$ 100 million dual currency (U.S. dollar/deutsche mark) loan requires the borrower to repay in deutsche marks if the currency appreciates above a set level. Unless the

borrower can reasonably expect deutsche mark revenues that exceed the amount required to repay at maturity, the borrower is exposed to the risk added by the loan. This type of loan does not provide downside protection against deutsche mark depreciation. Nonetheless, many developing countries use dual currency loans of the first type, primarily because of the cost reduction derived from the sale of option. The examples below describe several loans of the first type, and one of the third type.

74. The Central Bank of Turkey frequently uses deutsche mark-U.S. dollar loans, since Turkey can expect ample deutsche mark revenues from workers' remittances from West Germany. It agreed to a U.S.$ 100 million dual-currency syndicated loan, arranged by Bankers Trust International, in March 1988. The loan had a three-year maturity, with a deutsche mark option written on the U.S.$ 100 million principal. The premium from the sale of deutsche mark option was used to reduce the cost of funding. As a result, the loan carries a floating interest rate of 0.015 percent over LIBOR without any front-end fee. If it had been a conventional loan, the Central Bank would have paid 1.25 percent over LIBOR.

75. Air India and the Industrial Finance Corporation of India have also used this type of loan. In the case of Air India, a two-year deutsche mark option on U.S.$ 50 million was attached to a syndicated loan of U.S.$ 150 million. The option had a strike price of about DM 1.70 to the U.S. dollar and the option premium was used to pay the front-end fee. Accordingly, the loan carried a floating interest of 0.1875 percent over LIBOR for the first two years and 0.25 percent over LIBOR thereafter, with no front-end fee. The Industrial Finance Corporation of India used the same scheme with the Swiss franc as the second currency.

76. Indonesia used the third type (in which the borrower chooses the currency of drawing) several times for syndicated loans with Japanese banks. In October 1988 Indonesia contracted a 40 billion yen Euroyen revolving credit facility for three years. In this facility, Indonesia could draw up to 40 billion yen or its dollar equivalent for three years. Once the loan was drawn down, it would become a conventional (yen or dollar) loan, with an eight-year maturity and a five-year grace period, with a floating interest rate of 0.5 percent over LIBOR for the first three years and 0.625 percent over LIBOR thereafter. The front-end fee was 0.5 percent of the principal and the commitment fee was 0.25 percent. The all-in cost was slightly higher than those of conventional loans, due to the option feature. The loan gave the government an opportunity to choose the currency denomination of the debt over three years. Thus it provided Indonesia with an opportunity for better management of the external debt to avoid repeating a bitter experience in servicing debt denominated in an expensive currency (yen).

(3) A Loan with a Copper Swap (Mexico)

77. This scheme was used by a private company, but it has significant implications for risk management and finance of a country. A U.S.$ 210 million financing package with a copper swap was developed in 1989 by the New York branch of Banque Paribas (Paribas) for Mexicana de Cobre, S.A. de C.V. (MdC), a copper mining subsidiary of Grupo Mexico.[38]/ The loan was the first voluntary hard currency loan to a private Mexican company since the 1982 debt crisis. The syndicated loan, managed by Paribas, has a term of 38 months and a fixed interest rate of 3 percent above three-year LIBOR (as determined by

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[38]/ "News from Paribas" and other sources.

Paribas). The 12 equal quarterly payments started in December 1989. To eliminate MdC's copper price risk, a copper swap is attached to the loan, establishing a fixed price over the life of the loan for a portion of MdC's copper production. The proceeds of the loan were used to refinance the debt assumed when MdC went public and was acquired by Grupo Mexico in November 1988. The background and details of the scheme are provided below.

78. Because of the Mexican company's high credit risk, Paribas had to reduce the copper price risk; and the payment risk. The copper price directly affects MdC's earnings, and these earnings must be available for repayments over the life of loan. To deal with the copper price risk, Paribas introduced a copper swap. The payment risk was covered by establishing a collateral account and a long-term sales contract with a copper user.

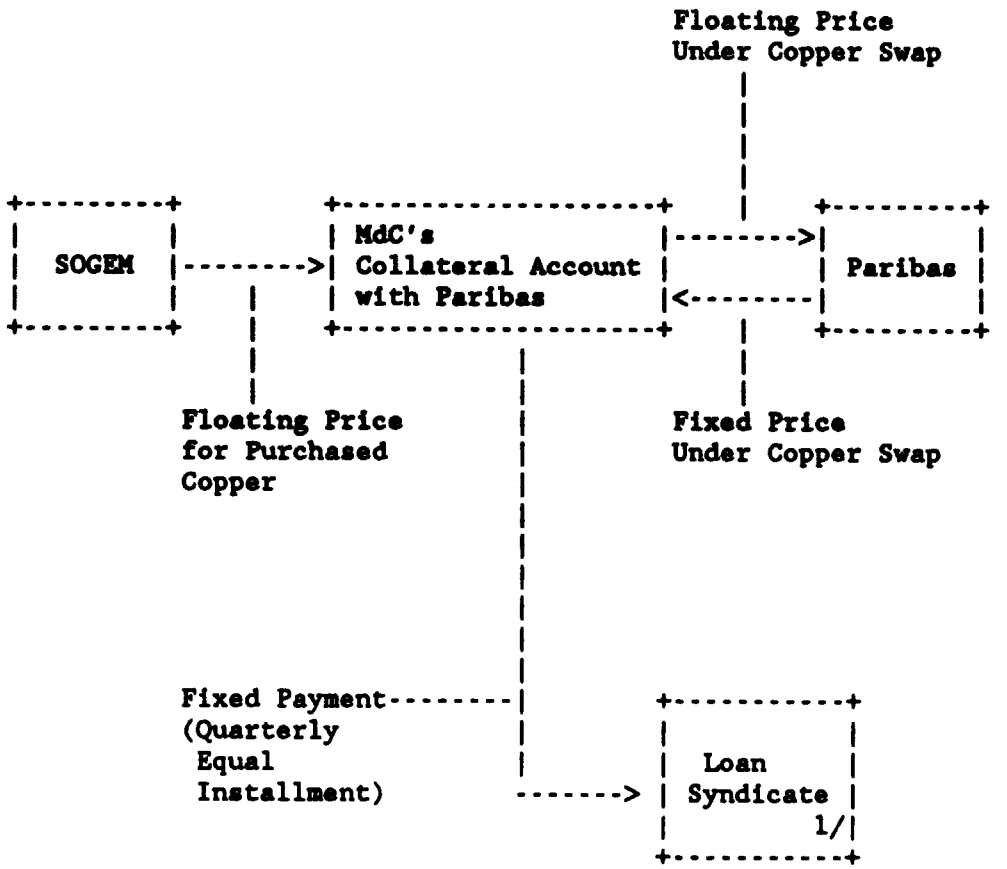
79. Paribas entered into a copper swap with MdC through its London branch. The scheme used is similar to the scheme described in the section on commodity-linked loans in Chapter III. MdC agreed to pay Paribas an amount based on a floating copper price it receives for its exported copper (based on the daily prices for copper on the London Metal Exchange) and Paribas agreed to pay MdC an amount based on a fixed price for the 38-month term of the loan. Paribas' fixed payment amount under the swap was matched with the amount necessary for the periodic loan repayments. Thus, the copper swap enabled MdC to assure it had funds sufficient to repay the loan, regardless of the copper price over the next three years.

80. To mitigate the payment risk, a long-term contract with a copper user and a collateral account were established. SOGEM S.A., a Societe Generale de Belgique subsidiary, agreed to purchase monthly 4,000 metric tons of copper anodes for the period of the loan from MdC's "La Caridad" mining and

Figure 1

MdC/Paribas Scheme

CASH FLOWS WITH REGARD TO LOAN REPAYMENTS



1/ Paribas acts as lead-manager.

smelting complex located in the northwestern Mexican State of Sonora. The amount contracted to be purchased accounted for about one third of MdC's copper anode production. SOGEM promised to pay an amount based on the average price for copper on the London Metal Exchange into a collateral account established by Paribas. Paribas then pays quarterly the fixed payment amount into the collateral account and draws the floating payment amount, under the copper swap agreement. Finally, the quarterly repayments to the participants of the syndication are made from the collateral account. In this way, sufficient funds to repay the loan are secured through the collateral account. Figure 1 illustrates the entire scheme. The scheme, together with MdC's history of excellent operating performance and Mexico's favorable economic reform policy, made possible the first voluntary lending to Mexico's private sector in hard currency since 1982.

(4) A Loan with Oil Options (Algeria)

81. Algeria's state-owned hydrocarbons concern, Sonatrach, entered into a loan agreement with a syndicate of international banks in November 1989. The loan, coordinated by Chase Investment Bank, London, consisted of a U.S.$ 100 million conventional floating rate loan (with a seven-year maturity and a four-year grace period) and a series of oil option transactions.[39]/ With this scheme, Algeria reentered the medium-term syndicated loan market at a significantly reduced cost. Sonatrach will pay an interest rate of one percent above LIBOR over the life of the loan. The cost would have been 3-4 percent above LIBOR, without the scheme. The proceeds of the loan were used

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[39]/ The International Commodity Markets Division of the World Bank provided Algeria with technical assistance for commodity-linked financing schemes.

to replace the expensive (4 percent above LIBOR) short-term loans, reducing Sonatrach's cost of interest service.

82. To reduce Sonatrach's cost of funding, two special arrangements were added to the loan. First, Sonatrach sold Chase four call options written on oil.[40]/ By selling the options, Sonatrach reduced the cost of funding, just as Turkey did in the dual currency loan mentioned earlier.[41]/ Oil options were used, instead of currency options, because oil is Sonatrach's major source of revenue. In this arrangement, Sonatrach will have to pay Chase a certain amount of cash if the price of oil rises above a pre-specified ceiling (for instance, U.S.$ 23 per barrel). This may not significantly increase Sonatrach's risk, since its revenue also will increase to cover this additional cost, if the price of oil rises. In short, the arrangement implies that Sonatrach traded some upside potential in its oil export revenues for the immediate reduction in cost of funding, by selling the oil options. Sonatrach will pay one percent above LIBOR over the life of loan, except for this contingent obligation.[42]/

83. The second arrangement was designed by Chase to form the syndicate successfully. To bring in other banks, Chase provided the syndicate with an opportunity for additional profits from oil price movements. Without this arrangement, the one percent margin above LIBOR from Sonatrach might have been too low for other banks to take part in the syndicate. Chase will pay the

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[40]/ The maturities of 4 options are 6, 12, 18, and 24 months.

[41]/ See Part 2 of this section.

[42]/ The scheme improved Sonatrach's creditworthiness by reducing the cost of debt service, but did not provide direct protection against a decline of oil price, since Sonatrach's repayments were not linked to oil prices.

syndicate an additional interest margin above LIBOR if the price of oil rises above or falls below a pre-specified price range. What the syndicate will receive is an interest rate of one percent above LIBOR from Sonatrach and an extra interest margin from Chase of 0.125 percent for one dollar move in the price of oil (if the price moves substantially). Note that this arrangement does not affect Sonatrach's payments. The extra margins are to be provided by Chase. This would have increased Chase's risk of oil price, but Chase eliminated the risk by complicated transactions in options market. Details of the arrangement and the option transactions are explained in Box II.

Box II

Sonatrach Scheme -- Cash Flows and Oil Option Transactions

1. Sonatrach scheme may seem confusing, because what Sonatrach pays and what the syndicate receives are not parallel. Several transactions in oil options were carried out to complete the scheme. The following are: each party's cash flows (or payoff) with respect to the price of oil; and the option transactions that structured these cash flows.

A. Cash Flows

2. Sonatrach pays an interest rate of 1 percent above LIBOR over the life of the loan, regardless of the oil price. Sonatrach also will have to pay Chase some additional cash if the price of oil rises above a preset ceiling. This obligation arises from Sonatrach's sale of four oil options to Chase. The obligation ends in two years since the options have a maturity of up to two years (6, 12, 18, and 24 months). By selling the options, Sonatrach reduced the cost of the seven-year loan.

3. The syndicate receives, from Chase, an extra interest margin indexed to the price of oil, in addition to the base margin of 1 percent over LIBOR from Sonatrach. A 0.125 percent margin will be added for every one dollar rise in the oil price, if the oil price moves above a reference range: the margin also will be added for every dollar fall in the oil price, if the oil price moves below the reference range. If the oil price remains within the range, there will be no extra margin. The reference range is set at U.S.$ 16 - U.S.$ 22 a barrel for the first six-month period, and will widen to U.S.$ 13 -U.S.$ 25 by the final maturity. The reference oil price is based on the price of the front month futures contract for West Texas Intermediate crude, traded in the New York Mercantile Exchange. The additional 0.125 percent margin, to be provided in accordance with the price of oil, is to be paid by Chase, which took on this obligation to attract other banks by providing them with an opportunity for additional profits from oil price movements.

4. Net cash flows to Chase are not affected by oil price movements. Chase perfectly hedged its cash flows against the oil price movements by making several transactions in the oil option market. Table 13 illustrates the scheme with respect to the price of oil.

B. Option Transactions

5. Cash flows have been structured by the option transactions described below (see Figure 2). To establish the entire scheme and to manage its own risk, Chase made three sets of oil option transactions with the syndicate, Sonatrach, and the option market. First, the extra margin payments indexed to the price of oil imply Chase's sale of oil options to the syndicate without receiving option premiums. For example, Chase's obligation to pay the syndicate an additional 0.125 percent interest margin for every dollar rise in oil price (if the oil price goes above U.S.$ 22 a barrel) for the first six months is equivalent to Chase's selling a six-month call option on oil with a U.S.$ 22 strike price.[1]/ By the same token, the obligation to add the margin for the fall in the oil price is equivalent to the sale of a put option on oil. In total, the scheme implies that Chase sold 14 call options and 14 put options to the syndicate.[2]/ Second, to hedge this implicit option position, Chase purchased same 14 put and 14 call options from the option market. Chase eliminated the oil option risk but paid option premiums to the market for this transaction. Lastly, Chase sold four call options on oil to the market, to cover the cost of the above option purchase. The risk of these options was covered by purchasing the same (four) call options from Sonatrach. Chase again eliminated the oil option risk and received option premiums from selling these four options to the market. Sonatrach did not receive a premium on the sale of the options to Chase but the financing costs of the loan were reduced. As a result Sonatrach's costs were lowered about two percent in the margin over LIBOR.

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[1]/ For the U.S.$ 100 million loan, an extra 0.125 percent interest margin for the six-month period is equivalent to an additional payment of U.S.$ 62,500 (U.S.$ 100 million x 0.125% x 1/2). The sale of a call option with a strike price of U.S.$ 22 written on 62,500 barrel of oil offers exactly the same payoff.

[2]/ A put and call option for each semi-annual interest payment over the 7-year period.

Table 13

An Illustration of Sonatrach Scheme

Oil Price and Interest Payments

A. What Sonatrach will pay:

(1) Interest payment to the syndicate (for the seven-year loan)

- LIBOR + 1 %, regardless of the oil price.
- This would have been LIBOR + 3%, without the scheme.

(2) Obligation to Chase on oil options

- Some additional payments to Chase during the first two years, if the oil price goes up beyond a ceiling price.

  Note: The additional payment amount and the ceiling price are not disclosed. An additional payment is assumed to be on the order of an increase of 0.5% in the interest margin for every dollar rise in oil price beyond U.S.$ 23 per barrel, for the purpose of illustration.

(3) Total payments: (3) = (1) + (2)

	Margin Over LIBOR					
Year 1 -- 2 (%)	1.0	1.0	1.0	1.0	2.0	3.0
Year 3 -- 7 (%)	1.0	1.0	1.0	1.0	1.0	1.0
Without Scheme (%)	3.0	3.0	3.0	3.0	3.0	3.0
Oil Price ($/bbl)	17.0	19.0	21.0	23.0	25.0	27.0

Table 13 (Continued)

An Illustration of Sonatrach Scheme

Oil Price and Interest Payments

B. What the syndicate will receive:

(1) Interest payments from Sonatrach

- LIBOR + 1%, regardless of the oil price.

(2) Additional interest margin from Chase

- An additional 0.125% margin for every dollar move in the oil price, if the price moves out of a preset range.

  A preset range here is assumed to be from U.S.$ 16 to U.S.$ 22 per barrel, for the purpose of illustration.

(3) Total Receipts: (3) = (1) + (2)

	Margin Over LIBOR						
From Sonatrach (%)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
From Chase (%)	0.50	0.25	0.00	0.00	0.00	0.25	0.50
Total (%)	1.50	1.25	1.00	1.00	1.00	1.25	1.50
Oil Price ($/bbl)	12.0	14.0	16.0	19.0	22.0	24.0	26.0

C. What Chase will pay and receive:

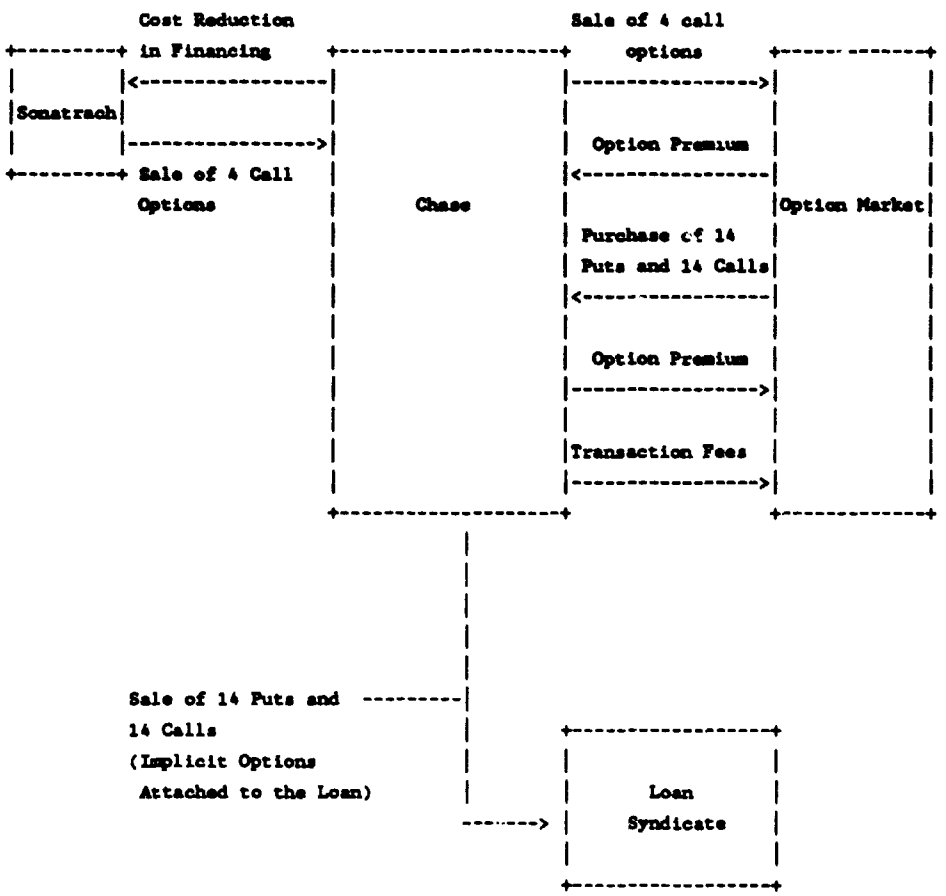
(1) Cash flows with regard to oil options

- Chase's net cash flows with regard to oil options will be zero, regardless of oil prices.
  Chase perfectly hedged against oil price with transactions in option markets.

Figure 2

Sonatrach/Chase Scheme

OPTION TRANSACTIONS



B. Issues in Using Financial Instruments

84. Three major factors have impeded the use of financial instruments by many developing countries: the financial market's perception of a country's creditworthiness; the cost of risk-management instruments; and the lack of an institutional framework for risk-management operations.

85. High credit risk has prevented many developing countries from using risk-hedging instruments. Forward, swap, and option contracts involve the consideration of the counterparty's creditworthiness. A forward contract exposes the counterparty to the risk of loss if the country defaults on its payment obligation during the life of contract. The longer the performance period (the length of forward contract), the greater the credit risk in the forward contract.[43]/ A swap contract involves a series of forward contracts and usually covers a longer period than a forward contract. In an option contract, the buyer is exposed to the performance risk of the seller, since the option seller solely bears the obligation to carry out the contract.

86. Active participants in the markets for these instruments--major international banks--generally have similar internal guidelines for country risk exposures. These banks prefer rationing access to charging a risk premium in accordance with their perception of the credit risk of countries. For a high-risk country, the banks allow no credit line for any transaction. They then may set a small credit line only for lending operations for a less risky country. If a marginally creditworthy country is particularly interested in instruments such as forward, swap, and option contracts, the banks set credit lines for these instruments, within the limit of a total

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[43]/ Folkerts-Landau (1989).

credit line.[44]/ Thus for some countries, using these instruments depletes the credit line for funding operations. This banking practice has been effectively blocking many developing countries' access to the markets for these instruments.

87. The cost of risk management instruments may be an impediment to using the financial instruments for countries that have already had problems raising necessary funds. Purchases of options, caps, and floors (that is, a series of options) require a significant premium up-front. Although the premium value of these instruments depends on the price volatility of the underlying asset, the strike price, and other factors, it usually accounts for a significant portion of the amount of the underlying asset to be hedged. For example, the premium on a six-month DM/U.S.$ put option with a strike price of U.S.$ 0.58/DM (or DM 1.7241/U.S.$) is likely to be more than 1.6 percent of the deutsche mark amount to be hedged (when the spot rate is DM 1.6800/U.S.$) [45]/ This means that hedging a DM 100 million likely costs more than U.S.$ 1 million.

88. Finally, risk management activities require considerable knowledge of these instruments and a proper institutional framework to carry out hedging operations. Considerable expertise is required in understanding the current risk structure of the country's economy, identifying proper instruments, and making actual transactions in the financial market. Setting up a proper institutional structure to undertake these tasks also requires a thorough

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[44]/ However, the banks may raise the ceiling of a total credit line, if they see the use of such instruments as improving a country's creditworthiness.

[45]/ The actual premium of this particular option was approximately 1.75% of the DM face value on Apr 20, 1990. However, the premium value almost continuously changes according to the DM/U.S.$ spot rate, DM/U.S.$ rate volatility, DM and U.S.$ interest rate, and the time to maturity.

understanding of the nature of risks and risk management instruments. Unfortunately, many developing countries lack the expertise for these operations. Substantial investments in information systems and human resources are necessary to train staff, to introduce an adequate reporting, recording, monitoring, and evaluating mechanism, and to establish internal control procedures.

(1) Removing the Impediments

(a) Creditworthiness

89. A country's risk-management efforts could supplement its on-going macroeconomic adjustment program to improve its creditworthiness. Risk-management may be seen as increasing its ability to repay its external debt. Commodity-linked financing could be a tool for a country to regain access to the market because the commodity-linked financing scheme contains a risk reduction component. As in the examples of Mexico and Algeria, commodity-linked schemes could provide a country with an opportunity to return to international financial markets.

90. In addition to commodity-linked schemes, two interesting schemes have been developed by the financial market to alleviate the credit risk issue: marked-to-market swaps, and reverse floating rate loans.

91. Marked-to market swaps, swap contracts with a futures-like feature, were developed by international banks to reduce the credit risk in conventional swap contracts. Under the marked-to-market swap, a cash payment is made periodically (for instance, every six months) to settle a gain or loss in the market value of that particular swap, as a price gain or loss is

settled daily in a futures contract. The swap's current market value is determined based on a set formula. So the performance period can be shortened to the next settlement date of the swap (for instance, six months) from the whole life of the swap contract (for instance, five years).[46]/ This shortened performance period has a significant implication in the banks' risk exposure calculation. For example, in a swap transaction between a U.S. corporation and Manufacturers Hanover Trust Co., risk exposure of the 11-year marked-to-market interest rate swap was calculated as about 3 percent of the face amount of the swap, while a conventional version of a swap with the same maturity would have carried a credit risk exposure of about 10 percent of the face amount.[47]/

92. A reverse floating rate loan might be particularly useful for a country with a significant amount of floating rate debt. A reverse floating rate loan supports the borrower's ability to pay by providing a hedge against the interest rate risk of the existing floating rate debt. In short, the interest rate charged on this particular loan will go up if the market interest rate goes down, and it will go down if the market interest rate goes up. Thus an increase in the interest payment for a portion of the existing floating rate debt can be offset by a decrease in the interest payment for the reverse floating rate loan. The reverse floating rate loan can provide a hedge against interest rate risk, effectively creating a set of fixed interest rate loans. Major international banks have reportedly started providing these loans to some corporate borrowers.

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[46]/ This paper does not discuss details of the marked-to-market swap scheme. For theoretical and technical details, see Folkerts-Landau (1989).

[47]/ International Financing Review, issue no.769 (Apr. 1, 1989).

93. A reverse floating rate scheme operates as follows. Let R_o denote the current interest rate for the fixed rate loan, R_t denote the floating interest rate, and P denote the loan principal. The interest payment for any period under the reverse interest rate loan can be written as

$$P \times [2R_o - R_t].$$ [48]/

For example, if the current interest rate for a five-year fixed rate loan is 9 percent, the interest rate to be charged on a five-year reverse floating rate loan is 18 percent minus the floating rate prevailing at the time interest is reset.[49]/ While data on the transaction costs is not publicly available, the costs would possibly be slightly higher than those of conventional loans.

(b) Purchase Costs of Options

94. While options provide an attractive risk-hedging opportunity, the cost of the up-front premium is substantial. The premium cost can be reduced by combining the sale of options with the purchase of options necessary for hedging risk. For example, if a developing country wants to buy options for hedging against a decline in the price of oil below U.S.$ 16 a barrel, the country can buy put options on oil with a strike price of U.S.$ 16, and at the same time, sell call options on oil with a strike price of, say U.S.$ 24. A part or the whole of the premium cost for the put options can be recovered by

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[48]/ For simplicity, the interest payment and the interest rate resetting are assumed to be annual.

[49]/ A reverse floating rate loan can be effectively made by a combination of a fixed rate loan and a interest rate swap. By promising to pay the fixed interest amount and to receive the floating interest amount under the interest rate swap, the fixed rate loan effectively becomes a reverse floating loan.

$P \times R_o$ (loan interest payment) + $P \times R_o$ (swap fixed interest payment) - $P \times R_t$ (swap floating interest receipt) = $P \times [2R_o - R_t]$.

the sale of call options. It is, however, important to note that the country effectively gives up a part of the upside potential in its future oil revenues by selling the call options. As described in the case of Algeria, the sale of call options implies trading future profit opportunities for the immediate revenue from option premiums. So proper risk assessment is critical when selling options.

95. The financial market provides various package products that include the purchase and sale of options. These package products tend to have peculiar names, like a "participating forward," a "cylinder," and a "collar." Whatever their name, they are usually option combinations. For example, a "cylinder" involves the purchase of a put option and the sale of a call option with a higher strike price. The buyer of a cylinder receives a payment if the price of the underlying asset falls below a pre-specified floor, and makes a payment if the price of the underlying asset rises above a pre-specified ceiling.[50]/ These package products might provide a convenient way to purchase and sell options at once.

(c) Human Resources and Institutional Frameworks

96. Multilateral agencies offer assistance with knowledge, expertise, and the institutional framework for dealing with risk-management instruments. Although some commercial services are also available, it is necessary to have substantial knowledge of the issues to evaluate the quality and cost of these

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[50]/ A "participating forward" involves the purchase of a call option and the sale of a put option with a smaller face amount and the same strike price, or vice versa. The face amount of a call and a put option is adjusted so that a premium cost of this product becomes zero. A "collar" involves the purchase of a cap and the sale of a floor. For a discussion of option combinations, see McMillan (1986), for instance.

services. The World Bank provides a variety of technical assistance programs to carry out risk-management operations for member countries, as described in the next section.

V. The World Bank's Assistance Programs

97. Three different programs are available from the Bank's three major branches: Finance, Policy Research and External Affairs, and Operations.

98. The Treasurer's Office provides a Financial Technical Assistance (FTA) program to cover two major areas: first, the use of international capital markets, and second, asset and liability management of currency and interest rate risk. The program focuses primarily on institution building for risk management. Upon request, a World Bank mission designs a preliminary asset/liability map of the country in terms of currency and interest rate risk, and identifies a core group of people in the Ministry of Finance or Central Bank who have the requisite technical and market background or who are in a position to acquire it. Then, over the following 18 to 36 months, the Bank offers this group a series of training program. The team works closely with the country to identify technical training needs. These include on-the-job trading experience in New York or London, guidance in assessing financial risks and launching new international financing schemes, and transferring knowledge, skills, and systems necessary for risk-management. The program's goal is to establish an expert risk-management group working in a computerized trading environment. Additional benefits could include: transferring risk management technology to other public and private sector entities; screening the proposals of investment and commercial banks; and providing a firm foundation for complex debt negotiations with commercial banks.

99. The Commodity Risk Management and Finance (CRMF) unit in Policy Research and External Affairs offers a CRMF program for developing countries that are dependent on commodity exports and/or imports. Together with

advising on currency and interest rate risk management, this program aims to assist a country to establish a framework for commodity risk management. The program includes: personnel training and institution building; technical assistance for establishing an optimal risk management strategy with respect to commodity price risk as well as interest rate and currency risk; and advice on financing with commodity-linked schemes. The training and institution-building process is similar to the FTA program's. As the process is often lengthy and the need to reduce commodity price risk exposures is often urgent, the CRMF program includes a Bank assessment of a country's overall financial risk exposure and an optimal risk-management strategy. The program also includes assistance in tapping the international market with commodity-linked financing schemes. The CRMF unit evaluates proposals for commodity-linked schemes by investment and commercial banks, advises a country on the costs and benefits of these schemes, and helps with the actual transactions. Algeria's oil-linked loan was a product of the CRMF program.

100. The Cofinancing and Financial Advisory Services in the Operations Complex provides an Enhanced Cofinancing Operations (ECO) program with financial advisory services. While the program is designed in a broader context to encompass the World Bank's overall cofinancing operations with other participants in the international market, the ECO program and the Financial Advisory Services can assist a country to manage financial risks. When necessary, the program also can provide a World Bank contingent obligation or guarantee to support a country's commercial borrowing and bond issue.

VI. Conclusion

101. This paper provides a primer of a concept of asset and liability management and financial risk management techniques. The paper draws on a number of studies already undertaken in this area, and provides a summary guide to a country's risk management activities. The main purpose of asset and liability management is to make the consideration of price risk explicit and to enable decisionmakers control risk exposure. By quantifying the sensitivity of a country's economic performance to changes in international prices, and by carrying out appropriate hedging activities to reduce risk, asset and liability management can reduce the adverse effects of external shocks and can complement the country's development planning or structural adjustment process.

102. The management of a country's asset and liability structure should minimize adverse changes in future net cash flows from international transactions. This paper emphasizes that it is the variance of future net cash flows--or economic exposure--that should be hedged. Two approaches to risk exposure measurement, a regression analysis and a simulation analysis, are discussed as useful ways to measure a country's economic exposure.

103. The paper also explores modern financial products and techniques, including forward, futures, swap, and option contracts as well as commodity-linked schemes, which can be used as hedging tools for a country's asset and liability management. These financial instruments provide flexibility, liquidity, and unique risk-hedging characteristics.

104. The applications described here illustrate how developing countries can use these techniques. The examples in Mexico and Algeria show

how commodity-linked schemes improved the countries' creditworthiness and enabled them to regain access to the international financial market. The examples also provide a better understanding of the costs and benefits of using modern financial techniques. By examining actual cases, a country's risk manager may see specific financial schemes that fit a country's specific needs.

105. The World Bank helps developing countries improve their risk-management by providing technical assistance programs. Substantial investments are necessary to acquire knowledge and skills, and to establish an institutional framework to handle modern financial techniques. These technical assistance programs are an essential element of on-going efforts to assist the developing countries in risk-management activities.

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Appendix

Eurodollar Futures Contracts

A. Contract Description

1. Eurodollar futures contracts are futures contracts on the three-month Eurodollar deposit rate. They are actively traded in four exchanges: the Chicago Mercantile Exchange (CME) in the U.S., the Singapore International Monetary Exchange (SIMEX) in Singapore, the London International Financial Futures Exchange (LIFFE) in the U.K., and the Tokyo International Financial Futures Exchange (TIFFE) in Japan. Contract specifications are quite similar throughout the four exchanges,[1]/ making active trading possible almost 24 hours a day around the world. Especially, the CME and the SIMEX established a "mutual offsetting" linkage so that positions established in the CME can be closed out in the SIMEX, and vice versa. In addition, the CME is implementing a system called "GLOBEX" in which futures transactions can be executed 24 hours a day through computer terminals installed around the world.

2. The delivery months of Eurodollar futures contracts are March, June, September, and December, up to three years out. The contract is made to mature on the third Wednesday of the delivery months. The last trading day of the contract is the second day prior to that Wednesday. For example, the trading of December 1992 contract[2]/ starts in December 1989 and finally ends on the second business day prior to the third Wednesday of December 1992.

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[1]/ See Table 5 for the CME's contract specification.

[2]/ December 1992 contracts are traded for the three-month interest rate of the period from December 1992 to March 1993.

When the contract matures, no physical delivery of Eurodollar deposit takes place. Any net change in the value of the contract at maturity is settled in cash.

3. Prices for Eurodollar futures are quoted in terms of a price index (100 minus rate of interest) and the minimum unit of price change is 0.01, or one-hundredth of one percent. For example, a price of 91.25 for the March 1990 contract means that a three-month interest rate implied in the futures contract for the period starting from March 1990 is 8.75 percent (100 - 91.25 = 8.75).

4. The daily cash settlements are made according to the closing price of the day. A price gain of 0.01 means a U.S.$ 25 profit per contract. This is equivalent to the change in the interest cost of a U.S.$ 1 million loan for three month period when the three-month interest rate changes by 0.01 percentage point (U.S.$ 1,000,000 x 0.01% x 90 / 360). Accordingly profits/losses are calculated by multiplying U.S.$ 25 by the number of contracts and prices gained or lost. The price gain or loss of the day is based on the difference between the closing price and the contracted price (or the difference between the closing price of the day and the previous day, if the position is carried over from the previous day). For example, if 100 contracts are sold at a price of 92.00 and the closing price is 91.80, the payoff is a profit of U.S.$50,000.[3]/ If the position is carried over to the next day and the closing price turns out to be 92.20, the loss of that day will be U.S.$ 100,000.[4]/

5. The final settlement price on the last trading day is determined

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[3]/ U.S.$ 25 x 100 x (9200-9180).

[4]/ U.S.$ 25 x 100 x (9180-9220).

by the exchange to converge with the spot interest rate. The CME clearinghouse randomly polls twelve banks actively participating in the London Eurodollar market at two different times during the last trading day: once at a randomly selected time during the last 90 minutes of trading and once at the close of trading. After excluding the two highest and lowest rate quotes from each polling, the average rate is used to determine the final settlement price. The settlement price is 100 minus the average rate.

6. The "initial margin" money is required by the exchange as collateral. It is currently U.S.$ 750 per contract. The margin per contract varies from time to time, since it is determined by the exchange according to the current market volatility. For example, at the end of 1987 it was U.S.$ 1,500 per contract, reflecting the volatile market movements after the October stock market crash. If U.S.$ 1,500 per contract is required, buying/selling 100 contracts requires a deposit of U.S.$ 150,000 (U.S.$ 1,500 x 100 contracts) in cash or U.S. Treasury bills.

7. Transaction fees vary from broker to broker. For a large customer a futures broker may charge U.S.$ 12-18 per contract for a trade on the CME. For a smaller customer, the brokerage fee may be U.S.$ 30 or higher. Actual fees are subject to negotiation.

B. Hedging Against Rising Interest Rate

8. Hedging operations against rising interest rates on floating rate debt involve selling Eurodollar futures contracts. If the debt is tied to the three-month U.S.$ LIBOR and the interest rate reset date coincides with the last trading day, the rate of interest on the next reset date can be almost perfectly locked-in by selling futures contracts.

9. For example, the interest rate on the next reset date of March 19, 1990 can be locked-in on January 3, 1990. Assume that the amount of debt to be repriced in March is U.S.$ 500 million and that the price of March 90 futures contract is 92.25 on January 3. By selling 500 contracts (U.S.$ 1,000,000 per contract x 500 contracts = U.S.$ 500 million), an interest rate of 7.75 percent in March can be locked-in (ignoring transaction costs and reinvestment risk of cash flows from daily settlements.) Cumulative profits/losses from the futures position offset the decrease/increase of interest cost for the next period (see Table A.1).

10. However, if the debt is tied to the one-year U.S.$ LIBOR, or if the interest reset date is not close to the maturity date of the contract, hedging the debt with 90-day futures contracts becomes imperfect.[5]/ Hedging against one-year interest rate with the three-month instrument involves "yield curve" risk, or the risk of changes in the term structure of interest rates. The risk arises from twists of the yield curve. Only if the three-month and one-year rate move perfectly together, can the hedging be perfect. Also "basis risk" arises when the futures position is closed before the maturity date, because the difference between futures price and the spot rate changes continuously. The risk can be eliminated only if the interest rate reset date coincides the contract maturity (when the futures price is forced to converge with the spot rate).

11. There are two basic ways for imperfect hedging against one-year interest rates: a "strip hedge" and a "stack hedge." The "strip hedge" involves selling a series of four contracts at once. For example, to hedge

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[5]/ Currently, no futures contracts on one-year U.S.$ interest rates exist. The FRA (forward) market is not liquid for one-year interest rates.

against the risk of one-year interest rate on U.S.$ 500 million to be reset in March, the hedge involves selling 500 contracts for each of the March, June, September, and December delivery. The total number of contracts sold is 2,000 (500 x 4), because one percentage change in the one-year interest rate results in four times as much interest cost as in the three-month interest rate.

12. The "stack hedge" usually involves selling futures contracts only with a near-by maturity (March contracts in the example). The number of (March) contracts to be sold can be calculated by the following equation;

Number of Contracts = Hedge Ratio x (Face Value of Debt / Size of Futures Contract) [6]/

where the hedge ratio is; [7]/

Duration Factor x Covariance Factor.[8]/

Covariance factor can be derived from historical relationship between the one-year and three-month interest rate by a regression analysis:

Changes in One-Year Interest Rate = a + b x Changes in Three-Month Interest Rate.

The covariance factor is b. In the previous example, the hedge involves selling 2,000 contracts in only March delivery, if the covariance factor is assumed to be one. Futures contracts are generally quite liquid in the front month contract (the contract of the nearest delivery). If the amount to be sold is large, the "stack hedge" may be preferred to avoid trading in less liquid delivery months.

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[6]/ The size of a Eurodollar futures contract is U.S.$ 1 million.

[7]/ This definition ignores time value of money, for simplicity.

[8]/ Duration of the 90-day futures contract is 1/4 of one year (= 90/360). Thus, the duration factor is 4.

Table A.1

Locking-in Interest Cost with Eurodollar Futures.

January 3, 1990:
(Today)

Debt to be reset on March 19, '90	:	**U.S.$ 500 mil**
Three-month LIBOR	:	**8.25%**
Eurodollar futures March 90 contract:	:	**92.25**

———> SOLD 500 March 90 contracts at 92.25

March 19, 1990:
(Reset Date)

If Spot LIBOR =	6.75%	7.75%	8.75%
Interest cost of U.S.$ 500 million debt for the next three months	$8,437,500	$9,687,500	$10,937,500
March 90 contract settlement price	93.25	92.25	91.25
Price gain (loss) in futures	(1.00)	0	1.00
Profit (loss) in 500 contracts	$1,250,000	$0	($1,250,000)
Effective interest cost	$9,687,500	$9,687,500	$9,687,500
Effective interest rate	7.75%	7.75%	7.75%

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